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PUSA

PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY
OF LONDON.

1916, pp. 449-756,
WITH 8 PLATES and 63 ~~TEXT-FIGURES~~.

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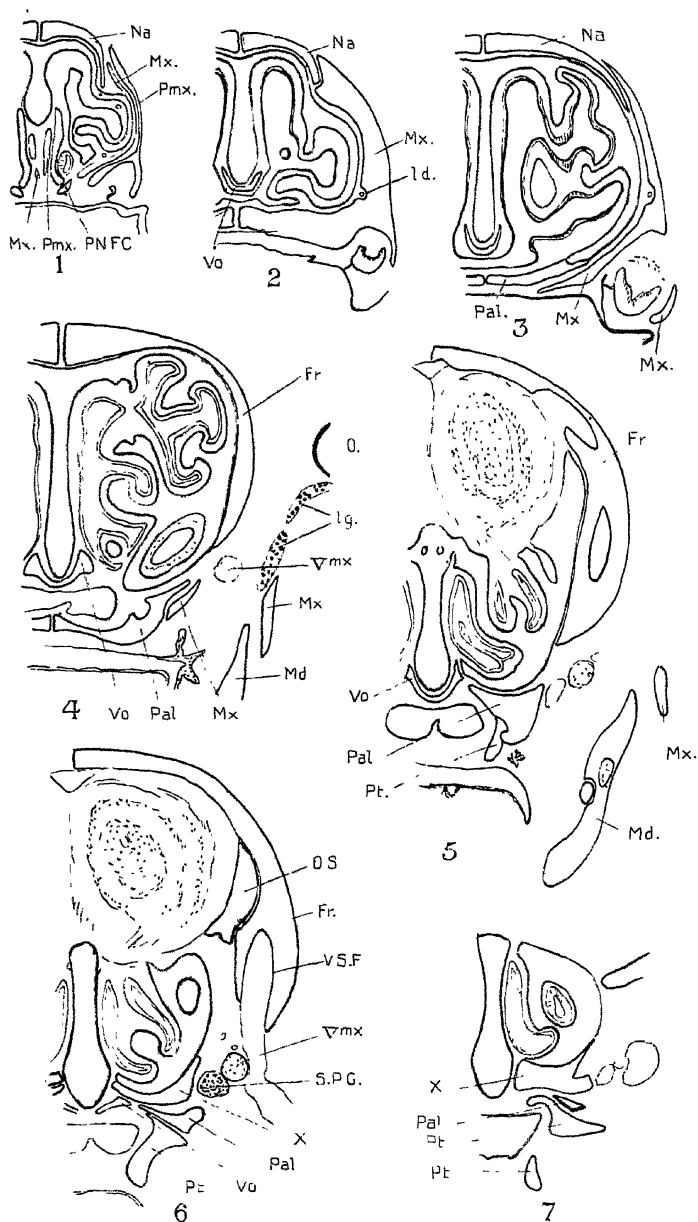
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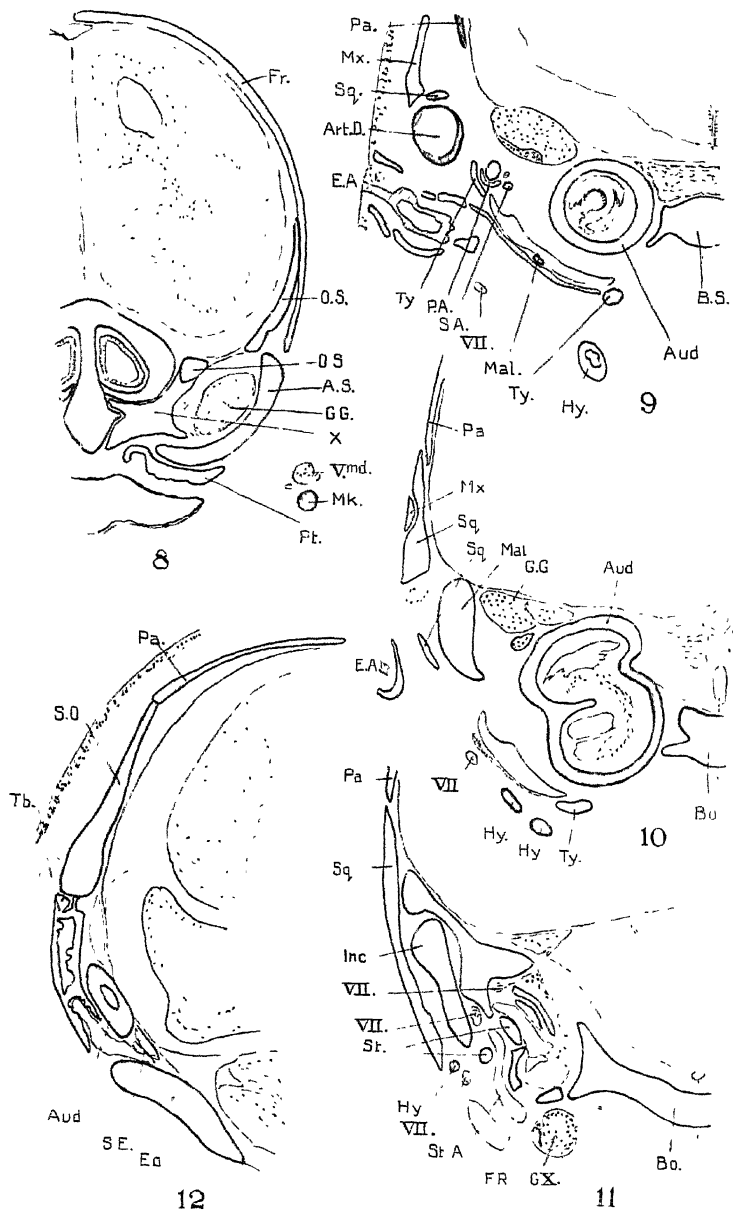
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PAPERS.

16. On the Structure of the Skull in *Chrysochloris*.
By R. BROOM, M.D., D.Sc., C.M.Z.S.

[Received April 25, 1916: Read May 23, 1916.]

(Plates I., II.* and Text-figures 1-3.)

The examination of the Organ of Jacobson and the nasal cartilages in the Cape Golden Mole, the results of which I recently communicated to the Society †, showed that *Chrysochloris* is not, as has been generally held, an ally of *Centetes*, nor indeed apparently of any of the small mammals which are usually grouped together as "Insectivora," and that the Golden Moles ought to be placed in an Order by themselves to which Dobson's name of Chrysochloridea may be applied. As the type is so unique, it seemed worth while to make a careful study of the skull.

Hitherto very little has been known of the skull of *Chrysochloris*. Though the animal is not at all rare, it is not often seen unless specially looked for, and probably only a very small proportion of the inhabitants of South Africa have ever seen one, except perhaps in a Museum. Most of the larger museums have a number of skins and skulls, but, as is the case with many small mammals, the cranial bones in the adult are so completely

* For explanation of the Plates see p. 458.

† P.Z.S. 1915, p. 347.

anchylosed that it is impossible to do much more than speculate on the structure. Dobson figures a nearly adult skull of one species which reveals some sutures, but only a very young skull could clear up most of the points in doubt, and until recently, so far as I am aware, no very young specimens have ever been obtained by any scientist. While residing at Stellenbosch, though I collected many adult *Chrysochloris*, I only succeeded in getting about half a dozen young specimens, and unfortunately I have no specimens which would show the early condition of the chondrocranium. Still, the skull of the newly-born *Chrysochloris hottentota*, which I have examined, is in such an interesting stage of development that it reveals clearly the nature of practically all the cartilaginous as well as the osseous elements.

Prof. J. P. Hill has very kindly had the head of the young *Chrysochloris hottentota* sectioned for me by his laboratory assistant, Mr. F. Pittock, and the facts revealed in the sections have been confirmed and amplified by the study of a prepared skull of a slightly older *Chrysochloris asiatica*.

Skull of young Chrysochloris asiatica.

The skull measures in greatest length 13.5 mm., and the basal length from the basioccipital to the premaxilla is 10.7 mm. The maximum width is 9.5 mm., and height 7.5 mm.

When viewed from above, the large size of the brain region, the narrowed orbital, and the short narrowed facial region give the skull a slight superficial resemblance to that of a small bird.

The premaxillae are small, irregularly square-shaped bones which articulate by one side with the maxillae and by another with the nasals. They contain the already calcified points of the three milk-incisors. The premaxilla forms a distinct portion of the hard palate behind the incisors and in front of the anterior palatine foramina.

The maxilla forms the greater part of the hard palate. Already the milk-canine, the three milk-molars, and the first molar are partly calcified. The maxilla forms about twice as large a part of the side of the snout as does the premaxilla. There is a large foramen for the large maxillary branch of the Vth nerve. The most remarkable thing about the maxilla is the way in which it forms the jugal arch. There is no trace of a jugal bone, and the whole arch is formed by a backward process of the maxilla which runs back as far as the glenoid cavity and articulates with the squamosal.

The nasals are relatively short. They measure 4.5 mm. in length, and the greatest measurement across the two is at the upper end, where it is 3 mm. In front the transverse measurement is 2 mm.

The lacrimal is very small and cannot be satisfactorily made out in this skull, though it can be detected in the sections of the earlier stage.

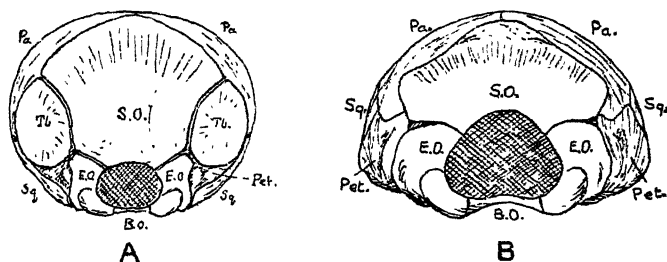
The frontal is relatively small, being only about half the size of the parietal. There is a distinct orbital constriction.

The large parietals each form nearly a quarter of the upper surface of the skull. Each articulates with its neighbour, and with the frontal, squamosal, tabular, and supraoccipital.

The squamosal is of moderate size but very peculiarly shaped. The upper squamous portion is much reduced, and behind the glenoid cavity there is a long posterior descending process which covers the petrosal and extends as far as the exoccipital. In front the squamosal articulates with the maxilla, but forms practically no part of the zygoma.

On the base of the skull the palatines, pterygoids, tympanics, auditory ossicles, vomer, basisphenoid, and basioccipital and exoccipital can be readily made out, but their relations and structure can be better understood from the reconstruction of the earlier stage.

Text-figure 1.



A. Occiput of young *Chrysochloris asiatica*. $\times 4$.

B. Occiput of young *Hemientetes* sp. $\times 3.5$.

For explanation of lettering see p. 458.

It is necessary, however, to consider more fully the structure of the occiput, as it is unlike that of any other known mammal. When the skull is examined posteriorly there is seen to be a very small basioccipital, a pair of small exoccipitals, and a relatively large supraoccipital, with no distinct interparietal. The relations and shapes of these will be seen in text-fig. 1. On each outer side of the supraoccipital is a rounded bone of moderate size which I regard as the tabular. It is a membrane-bone which articulates with the supraoccipital, the parietal, the exoccipital, and partly covers the petrosal or periotic. At this stage it does not quite reach the squamosal, but not improbably in a slightly more advanced stage it may be found to articulate with the squamosal. Whatever be the nature of this bone, it quite certainly, as will be seen later, is not formed from any part of the ear-capsule, and as it certainly occupies the exact position of the tabular in Therapsid and other early reptiles, it seems well to apply this name to it. As a large tabular occurs in

Cynodonts we may infer that the early mammals still retained it, and possibly *Chrysochloris* and its ancestors have never lost this ancestral character which all other known mammals have lost.

The occiput of *Chrysochloris* is very interesting when compared with its supposed ally *Hemicentetes* (text-fig. 1, B). It will be observed that the most striking difference is the entire absence of even a rudimentary tabular, whose place is occupied by lateral extensions of the supraoccipital and parietal. There are also considerable differences in the relative sizes of the other elements.

*Membrane-bones of the base of the skull of the newly-born
Chrysochloris hottentota.*

The skull of the newly-born *Chrysochloris hottentota* is now represented by 710 transverse sections. From sections 1 to 316 the series is complete and continuous. Here, unfortunately, the block of paraffin has been placed in the microtome in the reversed position and a wedge-shaped section of considerable thickness has been removed. Between sections 372 and 373 about eight sections are missing. Though these imperfections have increased the difficulty of reconstruction, they have fortunately not resulted in the loss of any fact of importance. In the reconstructions I have made, the gaps have been restored, as can be done with complete confidence, and the slight obliquity of the posterior half of the skull corrected.

As there is nothing of importance to be seen on the upper side of the skull that is not better seen in the slightly older dissected skull, I shall confine my description to the interesting condition of the base.

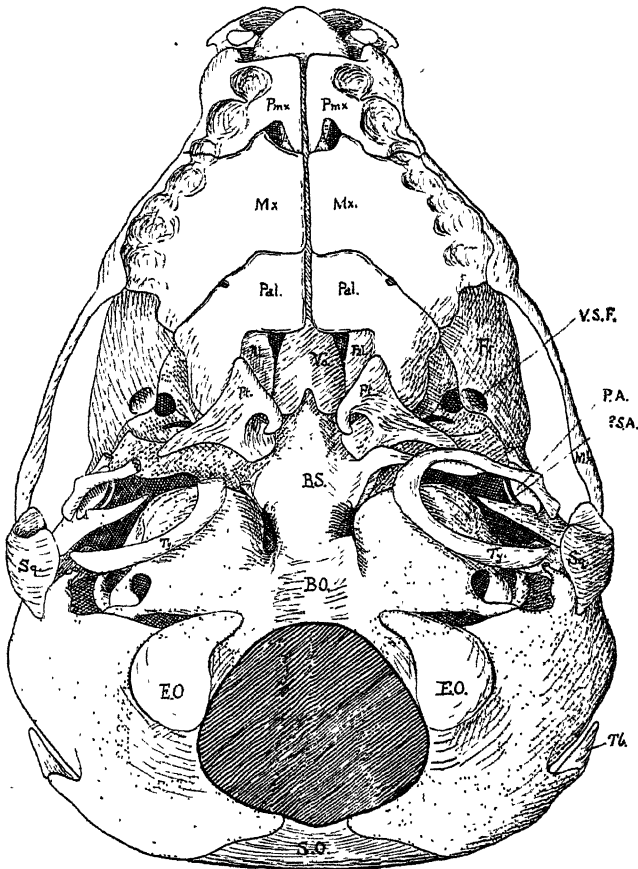
The whole palate is relatively shorter and broader than in the older stage. The premaxilla is already well ossified, and has two large open sockets for the 1st and 2nd developing milk-incisors. The cavity for the third developing tooth is only partly formed by the premaxilla, and partly by the maxilla. There seems little doubt, however, that this 3rd tooth is also, as has been generally held, an incisor. The palatine process is rather short, and there is a fairly large anterior palatine foramen.

The maxillary bone has a very broad but rather short palatal plate. There are distinct concavities for part of the 3rd milk-incisor, the milk-canine, the three milk-premolars, and for the 1st true molar. The dental lamina which is going to form the 2nd and 3rd molars is not at this stage supported by bone. From the lamina of bone which forms the outer protection for the dental germs, there is continued backwards the process of bone which forms the zygomatic arch. There is no distinct jugal.

The palatine is seen as a fairly large bone behind the maxillary. The plates forming the secondary palate are well

developed, and form the bony borders of the wide choana. Between the deeper portions of the palatines, the relations of which will be better understood from the sections, is seen the

Text-figure 2.



Reconstruction of base of skull of *Chrysochloris hottentota* (newly born) showing the membrane-bones. Portions of the right tympanic and the right basisphenoidal processes have been removed to show the underlying parts. $\times 12$.

For explanation of lettering see p. 458.

vomer. Superficial to the posterior part of the palatine is the peculiarly shaped pterygoid. The main part of the bone is

continued backwards from the palatine. A long slender outward process extends underneath the alisphenoid and in close relation to it. Downwards and backwards there passes a strong hooked process which supports the soft palate. The general shape will be readily understood from the restored figure (text-fig. 2).

External to the pterygoid and posterior to it is seen the large bony ring of the tympanic. It forms about $\frac{1}{2}$ of a circle. Lying between it and Meckel's cartilage is seen the prearticular or "goniale" of Gaupp; and immediately internal to the prearticular is a slender splint of bone which has not, so far as I am aware, been previously observed in mammals. It may represent the surangular of the reptilian jaw.

External to the tympanic is seen the developing squamosal. It curves round the auditory region, and in the figure is seen extremely foreshortened. In the slightly older skull the squamosal passes much further downwards and inwards and protects the whole of the posterior tympanic region which at this stage is exposed.

Behind the auditory capsule is seen the developing tabular; it is in close association with the anterior border of the supra-occipital.

In the figure given the only other membrane-bone seen is the frontal, a considerable part of whose lower border is shown. A large foramen shown is occupied by a venous sinus.

*Chondrocranium and cartilage-bones of the newly-born
Chrysochloris hottentota.*

Text-figure 3 shows a reconstruction of the chondrocranium, almost all the membrane-bones having been removed. The most striking general features are the great size of the occipital and auditory regions, the very small size of the orbitosphenoid, and the well-developed condition of the nasal capsules.

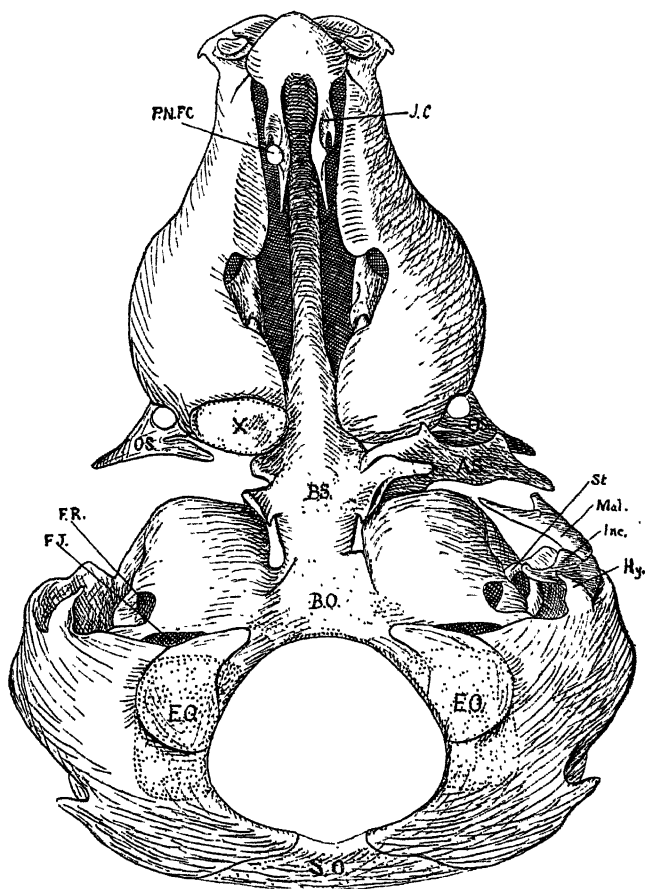
The internal structure of the nasal capsule is to some extent revealed in the figures of sections given. In the reconstructed figure the most interesting feature shown is the primitive structure of Jacobson's cartilage. It will be observed that there is, as in marsupials and a few lowly-organised Eutherians, an outer bar which is, however, not quite completely formed. There is a small posterior nasal-floor cartilage.

The orbitosphenoid is unusually small and does not extend far backwards as it does in marsupials and primitive Eutherians. It has a foramen rotundum for the rudimentary optic nerve.

On the base of the posterior part of the nasal capsule is a large membrane-bone of doubtful significance. Text-fig. 3 shows the appearance of the bone as viewed from below after the removal of the vomer, palatine, pterygoid, and alisphenoid. In the figures of sections given (Pls. I., II., figs. 6-8) the relations of the bone to the nasal capsule, to the orbitosphenoid,

and to the nasal septum, in addition to the relations to the membrane-bones and the alisphenoid, can be fully understood.

Text-figure 3.



Reconstruction of base of skull of *Chrysochloris hottentota* (newly born) with the membrane-bones removed. On the right side the auditory ossicles have also been removed and part of the basisphenoidal process and the whole of the alisphenoid. The posterior nasal-floor cartilage has also been removed from the left side. $\times 12$.

For explanation of lettering see p. 458.

Being above the alisphenoid, the bone is manifestly not one of the pterygoid group of bones. It is much too far back to be the

homologue of the reptilian paired vomer; and it cannot be the septomaxillary. It is no doubt the same bone as Parker found in a number of mammals and referred to as the postero-lateral vomer; but it is no part of the true vomer. Considering how very large a membranous ossification is formed in connection, as we shall see, with the basisphenoid, one may think of the possibility of this being a membranous exostosis in connection with the presphenoid, though at this stage, and even in the later one represented by the small skull dissected, there is no ossification of the cartilaginous presphenoid. In the meantime I think it safest to leave the significance of the bone as very doubtful.

The alisphenoid is fairly well developed but very narrow, and much more like a columella cranii than in any other mammal I know. It is still mainly cartilaginous, though commencing to ossify along the posterior border, and at its inner end there is considerable ossification which cannot altogether be separated from the ossification in membrane which is spreading out from the basisphenoid.

The basisphenoid is chiefly remarkable for the large membranous exostosis which forms a large process extending downwards and outwards. This process may be regarded as a basisphenoidal process comparable to the basisphenoidal process of many reptiles in having a true articulation with the pterygoid.

The auditory ossicles are relatively large.

The general structure of the auditory region will be more readily understood from the sections. The tegmen tympani is feebly developed.

The most interesting feature of the occiput is the fact that only a relatively small part of the supraoccipital is preformed in cartilage. The greater part is a membranous exostosis which fills in the median portion between the two sides. It might be argued that this median part is really the interparietal, but from the condition seen in the later states it seems better to look on the ossification as a supraoccipital in which only the lateral parts have a cartilage basis.

Description of the more important sections.

As I have in my previous paper figured and described the cartilages in connection with Jacobson's organ, and as the posterior part of the nasal capsule has a very complicated arrangement of turbinals which would require for the complete solution of its significance a much fuller comparison with other mammalian types than is at present possible, I shall leave any detailed account of the nasal cartilages till some future time.

Figures 1-6 (Pl. I.) represent sections 131, 185, 238, 280, 302, and 316 respectively, and show the general arrangement of the nasal cartilages.

Fig. 1, which is through the middle part of Jacobson's organ,

shows the small posterior nasal-floor cartilage. The anterior part of the maxilla is seen inside the premaxilla.

Fig. 2 shows the small procumbent inferior turbinal. The small developing 1st milk-molar is seen, and the very slender lacrimal duct.

Fig. 3 is through the anterior part of the palatine. The maxilla has the outer portion which protects the developing 3rd milk-molar no longer attached to the main part above.

Fig. 4 is through the plane of the rudimentary eye. The moderately large lacrimal gland is cut across. The relative positions of the palatine, maxilla with its zygomatic process, the vomer, and the frontal are shown.

Fig. 5 is through the anterior part of the pterygoid, and shows the relations of the palatine to the vomer internally and to the pterygoid inferiorly.

Fig. 6 is through the posterior end of the vomer. Above the vomer and the palatine is seen the problematic bone previously mentioned. It is seen to be in close relation to the nasal capsule and almost in contact externally with the spheno-palatine ganglion. A large venous sinus is seen passing out of the frontal bone.

Fig. 7 is a little posterior to the section shown in fig. 6, but not quite in the same plane, as already mentioned. The problematic bone is seen to be of large size, lying above the pterygoid and the posterior end of the palatine.

Fig. 8 (Pl. II.) is through the anterior part of the Gasserian ganglion. The alisphenoid is cut down the middle. The lower end is ossifying by exostosis. Below the alisphenoid is seen the pterygoid. Above these two elements and below the posterior end of the nasal capsule, is the large problematic "lateral vomer." Its upper outer angle is in close relation with the lower inner end of the orbitosphenoid.

Fig. 9 is through the anterior end of the auditory capsule and shows the cochlea in section. The basisphenoid shows part of the lateral exostosis which supports the capsule. The tympanic bone is seen cut across at both the outer and inner ends of the long flattened tympanic cavity. Inside the upper end of the tympanic is seen the curved prearticular or goniale which embraces Meckel's cartilage. Along the inner edge of this prearticular is another slender splint of bone which may represent the reptilian surangular. Above the prearticular is Meckel's cartilage, and inside this latter is seen the small chorda tympani nerve. External to Meckel's cartilage is shown the large cartilage which forms the articular end of the dentary, and above this is seen the posterior end of the zygomatic process of the maxilla and the anterior end of the squamosal. The section is through the main part of the external auditory meatus, which is seen surrounded by a series of cartilages belonging to the external ear.

Fig. 10 is through the posterior part of the malleus. It shows

the relations of the squamosal to the parietal and maxilla, and of the hyoid to the VIIth nerve and to the tympanic.

Fig. 11 is through the incus and the stapes. The stapes is seen pierced by the large stapedia artery. The incus is large and is seen mainly covered by the squamosal. The VIIth nerve is seen cut in three places, the inner part being continuous with the geniculate ganglion. In the lower part of the section is seen the large ganglion of the vagus nerve.

Fig. 12 shows the tabular bone and its relations to the supra-occipital, exoccipital, and auditory capsule. Whatever be its significance, it has manifestly, as will be seen, nothing to do with the auditory capsule.

Concluding observations.

The skull of *Chrysochloris* is in part a primitive, and in part a specialised and degenerate type.

It is primitive in the structure of Jacobson's cartilage, in the feeble development of the inferior turbinal, in the simple columella-like alisphenoid, in having a large maxillary zygomatic process, in the possession of a large complicated pterygoid which articulates with a large basisphenoidal process, and in the possession of a distinct tabular bone.

It is degenerate and specialised in the rudimentary condition of the orbitosphenoid, in the loss of the ectopterygoid interparietal, and jugal, and the lack of development of a zygomatic process of the squamosal.

The examination of the skull confirms the result of the examination of Jacobson's organ and its relations in showing that *Chrysochloris* is not a near ally of *Centetes*, and that it is not an Insectivore. Further, it is not allied to the Menotyphla, and ought to be placed in a distinct order Chrysochloridea.

Explanation of Lettering of Text-figures and Plates.

Art.D. articular head of dentary; *A.S.* alisphenoid; *Aud.* auditory capsule; *B.O.* basioccipital; *B.S.* basisphenoid; *E.A.* external auditory meatus; *E.O.* exoccipital; *F.J.* foramen jugulare; *F.R.* fenestra rotunda; *Fr.* frontal; *G.G.* Gasserian ganglion; *G.X.* ganglion of Xth nerve; *Hy.* hyoid; *Inc.* incus; *J.C.* Jacobson's cartilage; *l.d.*; *l.g.* lacrimal gland; *Mal.* malleus; *Ma.* mandible; *Me.* Meckel's cartilage; *Ma.* maxilla; *Na.* nasal; *O.* orbit; *O.S.* orbitosphenoid; *P.A.* prearticular; *Pa.* parietal; *Pal.* palatine; *Pet.* petrosal; *Pmr.* premaxilla; *P.N.F.C.* posterior nasal-floor cartilage; *Pt.* pterygoid; *S.A.* surangular; *S.E.* sacculus endolymphaticus; *S.O.* supraoccipital; *S.P.G.* sphenopalatine ganglion; *Sq.* squamosal; *St.* stapes; *St.A.* stapedia artery; *Tb.* tabular; *Ty.* tympanic; *V.* Vth nerve; *Vmd.* mandibular branch of Vth nerve; *Vmx.* maxillary branch of Vth nerve; *VII.* VIIth nerve; *Vo.* vomer; *V.S.F.* venous sinus of frontal; *X.* problematic bone at back part of nasal capsule.

EXPLANATION OF PLATES I. & II.

Figs. 1-12. Transverse sections of skull of newly-born *Chrysochloris hottentota*.

All sections are 15 times natural size.

ADDENDUM (July 12, 1916).—After my paper had been communicated to the Society, Mr. D. M. S. Watson called my attention to the fact that there is generally present in the Common Seal (*Phoca vitulina*) a bone which also appears to be a tabular. It has, of course, long been known that not infrequently a distinct bone occurs in the corresponding region in the human subject; and we may, I think, conclude that though most mammals have lost the tabular there is a tendency for it to reappear by reversion in forms in which, owing to the configuration of the brain, the occiput is largely developed.—R. B.

17. Fly Investigations Reports.—I. Some Observations on the Life-History of the Blow-Fly and of the House-Fly, made from August to September, 1915, for the Zoological Society of London. By WINIFRED H. SAUNDERS*.

[Received March 19, 1916: Preliminary report read by Prof. H. MAXWELL LEFROY, November 9, 1915.]

THE BLOW-FLY.

The breeding-material used was raw meat—a mixture of beef and mutton scraps. The meat was placed in pickle-jars, into which the flies were introduced; the tops were covered with muslin, and eggs were laid on the meat contained in these traps. The temperature of the room in which they were kept varied from 40–60° F.

Batches of Bluebottles (*Calliphora erythrocephala*) and Greenbottles (*Lucilia caesar*) were watched and compared, and the table given below shows very slight differences in the period of metamorphosis.

<i>Bluebottle.</i>		<i>Greenbottle.</i>	
Ova laid,	Sept. 1st–2nd.	Ova laid,	Aug. 24th.
„ hatched,	„ 2nd–3rd.	„ hatched,	„ 25th.
Larvæ pupated,	„ 14th–19th.	Larvæ pupated,	Sept. 4th–5th.
Flies emerged,	„ 27th.	Flies emerged,	„ 15th–29th.

As batches of eggs were laid they were isolated, and, so far as possible, the development was watched. The eggs were, as a rule, deposited in little crevices in the meat. The flies are attracted to moist meat whether fresh, foul, raw, or cooked, but they avoid dried meat.

Egg-laying.—This was observed through a binocular dissecting microscope. A fly which had been isolated in a test-tube with a piece of meat deposited eggs within an hour after being captured. The long ovipositor (about half the length of the body and a very sensitive structure) felt the surface before the passage of each egg.

The eggs which I saw laid were placed parallel with one another, and arranged in the typical compact little group.

In *hatching*, the egg splits longitudinally along a suture marked by a white line. It splits first at the broader end, on the convex side, which is in contact with the dorsal surface of the larva. The rupture is brought about by the pressure of movement within, and begins with a narrow slit, which lengthens as the maggot escapes. The empty shell very quickly shrivels.

* Communicated by Prof. H. MAXWELL LEFROY, M.A., F.Z.S.

Maggot.—The larval stage lasted from 10 to 16 days in most cases, but no moults were discovered.

Puparium.—The resting-stage covered from 8 to 13 days in the Bluebottle, but the Greenbottle spent up to 24 days in that condition.

Some eggs and maggots perished in a temperature of 38° C. The last batches remained in the maggot stage for many weeks, and they all succumbed at the beginning of November.

THE HOUSE-FLY (*Musca domestica*).

Eggs were laid on banana, either in cracks or crevices of the pulp or under the loose skin.

As batches of eggs were found they were isolated in small dishes. They were laid in material kept in a room where flies were bred. The maggots fed on banana and a mixture of bread, casein, and sugar moistened with water. Changes in growth were observed, but, as in the Blow-fly, no larval moults could be seen. The method of egg-laying and of hatching is similar to that of the Blow-fly.

Some batches of eggs were divided, one half being kept at the normal temperature of the room (40–60° F.) and the other at 38° C. (100°·4 F.). The results were as follows:—

Temperature 100°·4 F.

Temperature 40–60° F.

Batch 1. Eggs laid September 1st–2nd.

Hatched Sept. 2nd–3rd.

Hatched Sept. 2nd–3rd.

Pupated „ 7th–10th.

Pupated „ 15th.

Emerged „ 12th–16th.

Emerged „ 26th–27th.

Total 14 days.

Total 25 days.

Batch 2. Eggs laid September 3rd–4th.

Hatched Sept. 5th.

Hatched Sept. 5th.

Pupated „ 12th.

Pupated „ 16th.

Emerged „ 15th–16th.

Emerged „ 28th.

Total 11 days.

Total 23 days.

Batch 3. Eggs laid September 5th.

Hatched Sept. 6th.

Hatched Sept. 6th.

Pupated „ 13th.

Pupated „ 22nd.

Emerged „ 15th–16th.

Emerged „ 28th–29th.

Total 10 days.

Total 23 days.

Batch 4. Eggs laid September 6th–7th.

Hatched Sept. 7th.

Hatched Sept. 7th.

Pupated „ 14th–15th.

Pupated „ 23rd.

Emerged „ 16th.

Emerged „ 30th.

Total 9 days.

Total 23 days.

Conclusions.

The four batches of the House-fly show that the higher temperature hastens development—38° C. appears to be the maximum, the maggots cannot endure 40° C., and Blow-fly maggots perish at 38° C.

The experiments serve only to confirm records previously published.

The enquiry closed at the end of September, so that within a month there was no opportunity of repeating and checking the Blow-fly results, nor of observing hibernating habits with the approach of winter.

It is interesting to note that the Blow-fly will breed together with the House-fly in the mixture of bread, casein, sugar, and banana, and it would be worth while following the investigations through the winter with a view to clearing up points connected with hibernation, etc.

18. Fly Investigations Reports.—II. Trials for Catching, Repelling, and Exterminating Flies in Houses, made during the year 1915 for the Zoological Society of London. By WINIFRED H. SAUNDERS*.

[Received March 19, 1916; Preliminary report read by Prof. H. MAXWELL LEFROY, November 9, 1915.]

The trials were made at a country residence in Kent during August and September. House-flies were particularly numerous in the kitchen quarters and in an outhouse where poultry-food was prepared and stored. The living-rooms of the house were practically free from flies.

An inspection was made to ascertain whether any breeding-grounds existed on the premises. It was found that farmyard manure dumped into a manure-tip produced a large number of flies, though it was clear that the main source was beyond the control of the householder. Pigs were kept on this manure, which was allowed to accumulate for six weeks before being moved and stacked on some land a few yards away.

No steps had been taken to check the increase of flies, and the situation offered scope for testing under normal conditions the remedies which from experimental investigations were most promising.

Measures were taken :

1. To check the breeding of flies by treating the farmyard manure:—

- (a) In the manure-tip by watering the surface every four days with Westoran, in the strength of one part to twenty parts of water.
- (b) Stacked for use in the garden by dressing the surface with green oil and soil, in the proportion of one part oil to forty parts of soil per 100 square feet of surface.

2. To destroy flies by poisoning and by attracting to traps.

TRIAL I.—TRAPPING.

Balloon traps baited with (1) casein, sugar, and stout ;

(2) " " banana ;

(3) " " water

gave the following results :—

* Communicated by Prof. H. MAXWELL LEFROY, M.A., F.Z.S.

TABLE 1.—Mapweb Bait (casein and sugar in equal parts) and stout. Moistened daily with stout.

<i>Day.</i>	<i>Kitchen.</i>	<i>Servants' Hall.</i>	<i>Poultry Shed.</i>	<i>Total.</i>
1st to 3rd .	4 Musca.	6 Musca.	12 Musca.	22 Musca.
4th .	20 „ 3 Blow.	8 „	18 „	46 „ 3 Blow.
5th	42 „	32 „	23 „	97 „
6th ...	34 „	52 „	2 „	88 „
7th .	20 „	31 „	9 „	60 „
9th ...	11 „	25 „	13 „	49 „
Total ...	131 Musca, 3 Blow.	154 Musca.	77 Musca.	362 Musca, 3 Blow.

TABLE 2.—Mapweb Bait and banana.

<i>Day.</i>	<i>Kitchen.</i>	<i>Servants' Hall.</i>	<i>Poultry Shed.</i>	<i>Total.</i>
1st to 3rd	1 Musca, 6 Fannia, 1 Blow.	7 Musca.	39 Musca.	47 Musca, 6 Fannia, 1 Blow.
4th	2 Musca.	12 „	10 „	24 Musca.
5th ...	3 „	22 „	13 „	38 „
6th	6 „	22 „	10 „	38 „
7th ...	24 „	11 „	10 „	45 „
9th ...	8 „	1 „	3 „	12 „
Total ..	44 Musca, 6 Fannia, 1 Blow.	75 Musca.	85 Musca.	204 Musca, 6 Fannia, 1 Blow.

TABLE 3.—Mapweb Bait and water. Mixed two days previously; moistened daily with water.

<i>Day.</i>	<i>Kitchen.</i>	<i>Servants' Hall.</i>	<i>Poultry Shed.</i>	<i>Total.</i>
1st	2 Musca.	—	2 Musca.	4 Musca.
2nd .	5 „	13 Musca.	18 „	36 „
3rd .	13 „	47 „	1 „	61 „
4th .	31 „	14 „	27 „	72 „
6th .	22 „	16 „	2 „	40 „
Total .	73 Musca.	50 Musca.	50 Musca.	213 Musca.

TRIAL II.—FLYPAPER (EATIRMO).

Tested against Trial I. with the following results :—

Examined after two days :

TABLE 4.

1. Kitchen	52 Musca against 41 in 3 balloon traps ..	Bait and stout ...	11
		Bait and banana...	8
		Bait and water ...	22
2. Servants' Hall ..	135 Musca against 42 in 3 balloon traps ..	Bait and stout ...	25
		Bait and banana ..	1
		Bait and water ...	16
3. Poultry Shed ...	314 Musca against 18 in 3 balloon traps ...	Bait and stout ...	13
		Bait and banana..	3
		Bait and water .	2

N.B.—Of the House-flies caught in traps 69% were males.

TRIAL III.—SPRAYS.

Rooms were sprayed with the following (the windows were netted for two days, then fly-papers were exposed) :—

1. Flybane (aromatic disinfecting oil).
2. Exol.
3. Army Spray.

TABLE 5.

Flybane.

Day after netting was removed :—

<i>Kitchen.</i>	<i>Servants' Hall.</i>	<i>Poultry Shed.</i>
102 Musca.	105 Musca, eggs laid.	40 Musca.

Exol.

Two days after netting was removed :—

<i>Kitchen.</i>	<i>Servants' Hall.</i>	<i>Poultry Shed.</i>
130 Musca.	250 Musca.	—

Army Spray.

This preparation was arrived at late in the season (November), when, under normal conditions, flies had disappeared. It was, therefore, tested in some Army recreation-rooms, in a building where flies were bred for experimental purposes. The conditions were similar to those of ordinary cook-houses and dwelling-

rooms, food being served there which provided the usual attractions.

(N.B.—The Army Spray is prepared from Professor Maxwell Lefroy's formula by Heppell & Co., Knightsbridge, who supply it at 30s. per gallon concentrated. The diluted spray for use costs 1s. 6d. per gallon.)

TRIAL IV.—FLYKILLER.

Flykiller (treacle, arsenic, and water) was tested according to recommendations by Berlese, who used it with great success in Italy. Rags saturated with the solution were hung in places out of reach of domestic animals, and the mixture was sprayed on the roof, etc. Two applications were made, and the surrounding areas were carefully examined for dead flies the day after each. None were found, and there was no decrease in the number of flies which entered the house.

CONCLUSIONS.

From Trial III.:—

1. Flybane is effective in killing flies by contact, but it does not act as a repellent. There are two objections to its use in kitchens, wards, and dwelling-rooms. First, the paraffin oil taints food (although it is absolutely harmless); and, secondly, it leaves a mark upon the window-panes, furniture, etc.

2. Exol is effective in bringing the flies down—that is, it paralyses them sufficiently to sweep them up within half an hour, but about 50% finally recover.

It was found that all recoveries were made within 20 hours.

3. The Army Spray successfully kills flies by contact. Those which fall never recover, although they may struggle for some hours. It is not a deterrent.

Flies returned to the room sprayed with Flybane on the following day and in two days after Exol. They continued to be abundant after the manure treatments were made.

The fact that flies reappeared after the treatment of all farm-yard manure decided that they were being bred on neighbouring premises.

As regards poisoning, Flykiller proved a complete failure under the particular conditions that it was tested, probably due to a difference in climate.

Fly-papers were very successful, and in comparing figures they give better results than the traps.

Of traps the common balloon is the one which is recommended. It should be baited with casein and sugar in equal parts (Mapweb Bait), moistened with beer, stout, or banana. To keep rooms free from flies the most practicable procedure would be to spray daily with the new Army Spray (absolutely harmless to food and having a pleasant scent), and to set traps or fly-papers as explained above.

19. Fly Investigations Reports.—III. Investigations into Stable Manure to check the Breeding of House-Flies, made during the year 1915 for the Zoological Society of London. By WINIFRED H. SAUNDERS*.

[Received March 19, 1916: Preliminary report read by Prof. H. MAXWELL LEFROY, November 9, 1915.]

INTRODUCTION.

An extensive series of experiments was made in June and July for the purpose of finding a treatment for fresh stable manure, which would be effective in checking the breeding of House-flies, and which could be safely employed for agricultural purposes.

Owing to the increased price of borax, which before the war was the only substance in use for the purpose, the need for a treatment at a lower cost was pressing for military purposes, for farmers, horticulturists, and manure contractors.

Many practical obstacles arose in working out the solution of this problem.

Although many tons of manure were accumulated in artillery and cavalry camps, it was impossible to get a sufficient quantity conveyed to convenient trial-grounds owing to the difficulty of transport. A small amount was purchased, and, later, facilities were granted at the Army Veterinary Hospital, Woolwich, and on market-garden premises at Brentford, where stable manure was dumped. Experiments on manure, to test the action of various liquids upon flies and maggots, were carried out at Woolwich and at Brentford, and those on plants at the Royal Horticultural Society's Gardens, Wisley, at Messrs. Sutton's, Reading, and at the Horticultural College, Swanley.

This work on manure treatments was suggested and designed by Professor Maxwell Lefroy, under whose guidance all the experiments have been carried out.

A. MANURIAL EXPERIMENTS.

Experiments on fresh stable manure were made along two lines:—

1. To test the action of vapourisable liquids upon maggots present in the manure.
2. To test the action of substances as repellents to flies when applied to the surface of manure heaps.

Experimental heaps of definite sizes and shapes were constructed, and the strength of each application was in proportion to the cubic area of the manure.

* Communicated by Prof. H. MAXWELL LEFROY, M.A., F.Z.S.

The Application of Maggot Poisons.

The following liquids miscible in water were used :—

Miscible Tetrachlorethane (Westoran).

Miscible Fusel oil 1 %.

„ Pyridene 10 %.

„ „ 5 %.

Soluble Tar oil.

Higher Pyridene bases.

Neutral Blast-furnace oil.

Miscible oil, Heavy.

„ „ Light.

Methods.

1. Several small heaps, each of 10 cubic feet, were treated with Westoran and Miscible Fusel oil. Each heap was 1 foot high on a soil foundation, which was covered with peat-moss litter.

				Results on the 3rd day.	
		Westoran.		Miscible Fusel Oil, 1 %.	
1. One quart of solution	1 oz. diluted to 40 ozs.	Alive.		Alive.	
mixed intimately with the manure.	2 ozs. „ „	„		Escaped.	
	4 ozs. „ „	Dead.		Alive.	
2. Maggots put at $\frac{1}{2}$ from the bottom, one quart of liquid poured on at $\frac{2}{3}$.	1 oz. „ „	Alive.		Escaped.	
	3 ozs. „ „	Many dead.		„	
	5 ozs. „ „	Dead.		„	
3. Control ... ..	... ..	...		Escaped.	

2. Typical span-shaped manure-heaps of 220 and 110 cubic feet treated with Westoran and Miscible Fusel oil respectively.

	Westoran.	Miscible Fusel Oil, 1 %.
1 quart of solution to every 10 cubic feet of manure.	In the strength of 2 ozs. in 40 ozs. water (5 %).	In the strength of 4 ozs. in 40 ozs. water (10 %).

	Results.

	Results.	
Maggots put in three positions. The liquid was sprayed on as the heap was made up.	In 24 hours maggots in the centre dead; maggots near the top pupated; maggots at the bottom, near the edge, alive.	In 24 hours maggots all living. Third day some living, others pupated. Fifth day all dead.

3. 5-foot cubes of manure (125 cubic feet) were treated with Westoran, Miscible Pyridene, Kerosene, higher Pyridene bases, and Cresol.

Results.

Liquid poured down a hole in the centre in the strength of 25 ozs. diluted to 3½ gallons with water (=2 ozs. to the quart per 10 cubic feet) = 5⁰. Maggots put in six positions.

<i>Westoran.</i>	<i>Miscible Pyridene.</i>
In 24 hours :—	
All dead.	All dead.
In 2 days :—	
Dead near the centre.	Dead near the centre.

Liquid sprayed as stack was built in the strength of 24 ozs. diluted to 4½ gallons (= 1½ ozs. to 1 quart per 10 cubic feet). Maggots put in four positions.

<i>Kerosene.</i>	<i>Higher Pyridene Bases.</i>	<i>Cresol.</i>
In 24 hours :—		
3 lots dead.	3 lots dead.	2 lots dead.
In 2 days :—		
4th lot dead.	4th lot dead.	3rd lot dead.

4. Two heaps, each on a 5-foot-square base, 5 feet high with a 1½-foot-square top, treated with :—

Miscible Pyridene 5%, 1 quart to 2 gallons of water.
 „ Heavy, 2 quarts to 2 gallons of water.

Results.

Liquid was poured down the centre in the strength of 1 quart diluted to 2 gallons with water. Maggots were put in two positions.

In a few days flies were emerging from both heaps. The heaps were opened, and the oil was found to be concentrated in the centre. Both were hot, and puparia were present in the bottom edges of the heap and in the soil under the edges.

The manure used for the above experiments was not fly-infected; maggots enclosed in gauze were put into the heaps.

The Application of Fly-Deterrents.

The following non-miscible liquids were used :—

Neutral Blast-furnace oil.
 Blast-furnace Creosote.
 Green oil.
 Tar oil and Pyridene.
 Mineral oil and Pyridene.

They were applied by :—

(a) Mixing with soil in the proportion of one part liquid to forty parts soil. The soil was piled into a cone, and the oil

poured into a depression at the top and thoroughly incorporated with the soil by the "cone-and-quarter" method. The mixture was spread over the surface of the manure, forming a layer 1 inch thick.

(b) Treating the soil on which the manure rested, as well as the surface, by sprinkling the plain oil or spreading oiled soil.

(c) Sprinkling plain oil evenly over the surface of the manure.

Methods.

I. Three manure-heaps, each on a base $6\frac{1}{2}$ feet square, rising to 3 feet in the centre, were treated with Neutral Blast-furnace oil, Blast-furnace Creosote, and Green Tar oil mixed with dry soil in the proportion of one part oil to 40 parts soil, spread evenly over the surface, forming a layer 1 inch thick. Maggots were put under the treated layer on the fourth day.

Results.

<i>Neutral Blast-furnace Oil.</i>	<i>Blast-furnace Creosote.</i>	<i>Green Tar Oil.</i>
Living after 2 days.	Dead in 2 days.	Dead in 24 hours.

II. Four manure-heaps, each on a base 7 feet square, rising 3 feet to a top 3 feet square, were treated with:—

Green oil.	} $\frac{1}{2}$ gallon to 10 gallons of soil.
Green oil and Pyridene.	
Neutral Blast-furnace oil.	
Control.	

The mixture was spread evenly over the surface. All the manure was infected.

Results.

In three days larvæ were found dead in the treated heaps. In six days the Control heap contained large maggots. The treated heaps remained immune.

III. Four manure-heaps, each on a base 4 feet 6 inches square, rising 18 inches in the centre, were treated with:—

1. Mineral oil and Pyridene. $\left\{ \begin{array}{l} \frac{1}{4} \text{ gall. sprinkled over base.} \\ \frac{1}{4} \text{ gall. with 10 galls. soil on surface.} \end{array} \right.$
2. Mineral oil and Pyridene. $\frac{1}{4}$ gall. with 10 galls. soil on surface only.
3. Tar oil and Pyridene $\frac{1}{4}$ gall. with 10 galls. soil on surface only.
4. Tar oil and Pyridene .. $\left\{ \begin{array}{l} \frac{1}{4} \text{ gall. with 10 galls. soil on surface only.} \\ \frac{1}{4} \text{ gall. sprinkled over base.} \end{array} \right.$

The manure contained many full-grown larvæ, but the heaps were too small to heat.

Results.

Flies emerged from the mineral-oil heaps through places where straw prevented the treated soil from lying evenly. They were

not seen emerging from the Tar-oil-treated heaps, and these were covered with muslin. Flies emerged later in small numbers.

<i>Tar Oil and Pyridene; Top and Under.</i>	<i>Tar Oil and Pyridene; Surface only.</i>	<i>Mineral Oil and Pyridene; Top and Under.</i>	<i>Mineral Oil and Pyridene; Surface only.</i>
Flies emerged, no pupæ present in the soil under- neath.	Few flies emerged, pupæ found in the soil under- neath.	Many flies emerged, no pupæ in the soil.	Flies emerged, some pupæ in the soil.

Results show that the Tar oil prevents the maggots from migrating into the soil below the manure-heap. While forming a barrier to larvæ, and acting as a deterrent to flies, it does not prevent flies which emerge from pupæ present in the manure from escaping through gaps provided by the straw of long manure.

N.B.—Maggots placed on soil mixed with (1) Green Tar oil, (2) Neutral Blast-furnace oil burrowed into it away from the light, and were dead in ten minutes.

IV. Four manure-heaps, each on a base $6\frac{1}{2}$ feet square, rising 3 feet in the centre to a point, were treated with :—

Neutral Blast-furnace Oil.	} $\frac{1}{2}$ gallon with 20 gallons soil.
Blast-furnace Creosote.	
Green Tar oil.	
Control.	

The treated soil was spread evenly over the heaps. Maggots were placed in each and the temperatures recorded. In areas of about 95° F. the larvæ were dead in all but the Control heap.

Results.

In five days the Control heap was infected while the treated heaps remained immune. Observations showed that conditions were favourable to breeding, but that flies were repelled from the treated heaps.

V. Five heaps, each on a base 7 feet square, rising 3 feet to a top 3 feet square, were treated with :—

Neutral Blast-furnace oil.	} $\frac{1}{2}$ gallon to 10 gallons soil.
Blast-furnace Creosote.	
Green Tar oil.	
Miscible oil and Pyridene.	
Control.	

Results.

In four days maggots were found in the heaps treated with Blast-furnace Creosote and Miscible oil and Pyridene. These two stacks were destroyed. For ten days no maggots were found in the other two, although conditions such as moisture,

temperature, etc. seemed suitable for breeding, and untreated manure in the same condition became infected.

VI. Five heaps of long manure on a base 7 feet square, rising 3 feet to a 3-foot square, were treated with :—

Mineral oil and Pyridene	1 gallon with 40 gallons of soil.
" " "	$\frac{1}{2}$ " " 20 " "
Tar oil and Pyridene ..	1 " " 40 " "
" " "	$\frac{1}{2}$ " " 20 " "
Control.—Soil only.	

Results.

In two days maggots were found dead on the surface of the Tar-oil-treated heaps, and a live one was wriggling in the full light on the top. In four days the heaps contained large dead maggots, and the Control contained full-grown maggots and puparia. Flies had evidently been laying in the Control. The treated heaps were still free in ten days.

VII. Three manure-heaps on a base 7 feet square, rising 3 feet to a 3-foot square. The manure was long but not infected. They were treated with :—

Mineral oil and Pyridene 10 0 ⁰ / ₁₀ .	$\left\{ \begin{array}{l} \frac{1}{2} \text{ gall. sprinkled over the base.} \\ \frac{1}{2} \text{ gall. with 20 galls. soil on surface.} \end{array} \right.$
Tar oil and Pyridene 10 0 ⁰ / ₁₀ .	Ditto.

Results.

In five days the Control and Mineral-oil heaps contained maggots, but none were present in the Tar-oil one. It was warm, moist, and appeared very suitable. Observation showed that flies came readily to the heaps and that Pyridene appears to be attractive, but the attraction is temporary.

VIII. One large heap of mixed manure on a base 9 yards by 7 yards was treated with a watering of pure non-miscible liquids. Seven gallons were used for a light watering. This was at the same rate as that used in soil-treatment, showing that an application of 1-inch-thick treated soil at one part in forty is about equivalent to a light watering with the liquid.

N.B.—There was a Control heap to each set of experiments which was examined for eggs and maggots, and where the conditions proved unsuitable for breeding no conclusions were drawn from the Control heaps.

B. PLANT TRIALS.

All the substances used in the manurial experiments were tested on plants in open plots, in pots, and in frames.

I. PLOTS.

1. At Wisley, Blast-furnace Creosote, Neutral Blast-furnace

oil, and Green Tar oil were mixed with soil at the rate of 1 in 40, and used with manure in the proportion of 10 gallons of oiled soil to 100 gallons of manure. Ten barrow-loads of treated manure was dug into each plot sized 44 feet by 8 feet. French beans and turnips were sown.

Results.

	Gross weight of crop in lbs.	
	<i>Turnip.</i>	<i>Bean.</i>
Blast-furnace Creosote .	243 $\frac{1}{2}$	20 $\frac{1}{2}$
Control	270	16
Neutral Blast-furnace oil . .	215 $\frac{1}{2}$	18
Control	232 $\frac{1}{2}$	17 $\frac{1}{2}$
Green Tar oil	170 $\frac{1}{2}$	18

2. At Messrs. Sutton's, Reading, who supply the following report, substances were tested on mustard, being a quick-growing crop:—

Fifteen plots in all were treated, and the experiments were carried out in two series, Series I. consisting of Plots 1 to 10, and Series II., Plots numbering from 11 to 15. Each plot was about 1 square pole in area. The land on which these experiments were conducted was previously under mangel plants, and all of it had precisely a similar treatment.

Series I.—The heaps of dung for these plots were dug in on June 26th, 1915, and the mustard sown on June 28th; the following tables serve to indicate the character of the dressings with which the dung was treated, the dates on which the seed germinated in each plot, and the respective merits of the plots at the dates mentioned.

Series II.—The dung in this case was dug in on August 13th, 1915, and the mustard sown on the following day; the results will be found in the tables already alluded to.

It is most satisfactory that in both series not a single crop should have failed, and that consequently it may be assumed that dung treated with the chemicals employed by Professor Maxwell Lefroy may be used for manurial purposes without hesitation.

Series I.

Control No. 1 (untreated).

Aa. Miscible oil, Heavy	24	ozs. diluted to 4 $\frac{1}{2}$ gallons.
Ab. " " " .	48	" " 9 "
Ba. " " Light .	24	" " 4 $\frac{1}{2}$ "
Bb. " " " .	48	" " 9 "
Cu. " " 'P' .	24	" " 4 $\frac{1}{2}$ "
Cb. " " " .	48	" " 9 "
Da. " " 'F' .	24	" " 4 $\frac{1}{2}$ "
Db. " " " . . .	48	" " 9 "
Ea. Westoran or Miscible Tetrachlorethane.	24	" " 4 $\frac{1}{2}$ "

*Dates of Notes.**Notes to Trials.*

July 5th, 1915.	Germination showing in each and fairly general in all.
July 10th, „	‘Control’ and six following are all uniformly good and practically no difference between any. Da and Db not quite so even as the preceding, not uniform in growth, gappy. Ea in much the same condition as ‘Control.’
July 24th, „	No real difference between ‘Control’ and six following lots. Da and Db continue the least satisfactory. Ea good lot and equal to ‘Control.’
July 31st, „	‘Control’ and six following lots still much alike. Da the weakest, but not really poor.
Aug. 13th, „	The plots were inspected by Professor Maxwell Lefroy and Dr. Stenhouse Williams.

Series II.

Manure received August 13th and plots sown August 14th.

Control No. 2.

Ac. Manure oil No. 1 with earth.

Bc. „ „ No. 2 „ „

Cc. „ „ No. 3 „ „

*Dates of Notes.**Notes to Trials.*

Aug. 21st, 1915.	All plots germinated satisfactorily.
Aug. 31st, „	Not much difference between ‘Control,’ Bc, and Cc. Ac not quite so strong.
Sept. 4th, „	‘Control’ and Bc the two strongest. Ac the weakest.
Sept. 11th, „	All four lots are good, but of the four Ac is slightly the weakest.
Sept. 18th, „	Now all very strong and good, and little difference to be seen between any.

II. FRAMES.

1. At Swanley, melons and cucumbers were planted in frames and grown on the French system. Each plant was planted in soil over a cubic foot of treated manure. The treatments were :—

Westoran.	} 5 ozs. diluted to one quart per 10 cubic feet.
Miscible Fusel oil 1 ⁰ 0.	
Miscible Pyridene.	
Miscible oil, Heavy.	
Miscible oil, Light.	
Kerosene.	
Higher Pyridene bases.	
Cresol.	} 5 ozs. to 10 cubic feet.
Heavy Tar oil and Cresol.	
Neutral Blast-furnace oil.	
Non-Miscible Tar oil.	5 ozs. to 10 cubic feet.
Non-Miscible Pyridene.	5 ozs. to 10 cubic feet.
Control.	

Results.

All the plants grew to maturity and bore normal crops, with the exception of the Westoran-treated one, which died.

2. Melons planted in soil over one cubic foot of treated soil and manure and grown in a French frame. The treatments were :—

Neutral Blast-furnace oil.
Blast-furnace Creosote.
Green Tar oil.

All gave normal results.

3. Melons planted in soil over a hot-bed of manure treated with Westoran in the strength of 2 ozs. diluted to one quart with water per 10 cubic feet. The plants were grown on the French system, and the results were normal.

4. Cucumbers were planted in soil over a hot-bed of manure treated with Miscible Pyridene 10% in the strength of 2 ozs. diluted to one quart per 10 cubic feet. They were grown on the French system with normal results.

N.B.—In the case of 3 and 4 the manure used was treated a fortnight previous to planting. In all the other experiments the manure was used immediately after treatment, so that nothing was lost. In actual practice a certain amount would be lost before use.

III. Pots.

1. At Wisley, white mustard was sown in 7-inch pots on loam and treated manure in equal parts. They were kept in a cool frame and shaded.

The following chemicals were used in the proportion of 1 part diluted to 3 with water. The experiments formed three series :—

1. Treated with 30 c.c. of the mixture.
2. " " 150 " "
3. " " 300 " "

Results.

Miscible oil, Heavy	Rapid germination.	Good crop.
" " Light	" "	" "
Miscible Pyridene, Series 1 and 2 ...	" "	" "
" " " 3	Uneven "	Poor "
Miscible Fusel oil, Series 1	" "	" "
" " " 2 and 3	Even "	Good "
Westoran, Series 1	" "	" "
" " 2 and 3	Poor "	Poor "
Kerosene.	Good "	Good "
Higher Pyridene bases.		
Cresol.		
Heavy Tar oil and Cresol.		
Neutral Blast-furnace oil.		

The plants were grown for two months, and at the flowering stage all the results were equal and even with the Control. The Westoran treatment resulted in a checked thin crop, but the plants reached maturity.

2. Cape Pelargoniums and Adiantums (maidenhair ferns) were repotted from 60's into 5-inch pots with equal parts loam and treated manure. The treatments used for mustard in Experiment 1 were repeated on twenty-two species of *Pelargonium* and on *Adiantum henslowianum*.

All grew quite healthily, and at the end of seven weeks the treated plants looked as well as the Control.

3. At Swanley, melons were potted with a compost of equal parts treated manure and loam, and grown in a temperature of 60–80° F. For each treatment 1 quart of liquid was used with 4 ozs. and 3 ozs. of the chemical.

Westoran at both strengths killed the plants, but those treated with the following behaved normally compared with the Control. They were kept until pot-bound :—

Miscible Fusel oil.	Heavy Tar oil and Cresol.
Miscible Pyridene 10 ⁰ / ₀ .	Fusel oil.
Miscible oil, Heavy.	Neutral Blast-furnace oil.
Miscible oil, Light.	Tetrachlorethane.
Miscible Pyridene 5 ⁰ / ₀ .	Miscible Pyridene 15 ⁰ / ₀ Molar.
Kerosene.	Soluble Tar oil.
Higher Pyridene bases.	Blast-furnace Creosote.
Cresol.	Green Tar oil.
Carbon Tetrachloride.	

4. Cucumbers, for which the methods of No. 3 were employed, were treated with :—

Non-miscible Tar oil,
Non-miscible Pyridene

with perfectly normal results.

CONCLUSIONS.

The experiments show that the investigations led to two very successful treatments :—

1. The surface-dressing of manure with Green Tar oil or with Neutral Blast-furnace oil and soil.
2. The application of Tetrachlorethane.

Both treatments successfully kill maggots in the manure and are harmless to plants.

The Tar oil has a permanent effect in being resistant to rain, while the effect of Tetrachlorethane lasts only while the liquid vapourises, and in time the poisonous vapour escapes.

The treatments began with the series of vapourisable liquids which led to the surface applications. Although these treatments are more satisfactory than any hitherto recommended, it is admitted that there are still some doubtful points in connection with the relation of the migration of the larvæ to the condition of the manure due to chemical action other than changes in temperature. For the early experiments infected manure was not obtainable; maggots enclosed in gauze were placed in different positions in the stacks. When House-flies became abundant naturally infected manure was used.

The Tar-oil treatment is recommended for large accumulations of manure, either in military camps or for horticultural purposes, in the proportion of one part of oil to forty parts of soil. One gallon of liquid mixed with forty gallons of soil covers 100 square feet. The oils are products of the first distillation of tar. For large quantities the price is 1s. per gallon, making the cost of the treatment 1d. per cubic yard for surface treatment only and 2d. per cubic yard for treatment of the ground and of the surface.

The value of manure is 1s. 9d. the cubic yard.

Treat the manure which is added to a heap every five days, and if fresh ground is to be covered, when adding to a heap, oil the ground first.

Maggots present in manure which is stacked on soil dressed with a Tar oil cannot escape into the ground to pupate. The manure ferments normally when treated with the oil, and the maggots perish in the treated soil to which they are driven, or they pupate in a stack which is cool (Experiment III.). That a manure-stack treated with Green oil or with Neutral Blast-furnace oil will remain immune to fly-attack has been confirmed by Experiments II., IV., V., VI., and VII., where in each case the Control became infected.

That the treatment is harmless to plants is shown by the results of Plant Trial I. (Plots) and III. (Pots) and Messrs. Sutton's Series II., Ac and Cc.

The vapour treatment with Tetrachlorethane, in the miscible or in the pure form, is recommended for small quantities of manure and for fresh manure used for hot-beds in the strength of 2 ozs. to 10 cubic feet of manure.

Tetrachlorethane is a heavy liquid, specific gravity 1.6 and boiling-point 147° C. It is non-inflammable and commercially available. The price of pure Tetrachlorethane is 35s. per cwt. and that of Westoran 52s. per cwt. That a manure-stack treated with Tetrachlorethane will effectively kill maggots has been proved by Experiments I., II., and III., and that used with manure at 2 ozs. per 10 cubic feet is safe for plants, by Trials 3 (Frames) and Messrs. Sutton's Series I., Ea.

It is worth noting that all the treatments have been tested in intensive culture with satisfactory results at the strengths recommended.

20. Fly Investigations Reports. IV.—Some Enquiry into the Question of Baits and Poisons for Flies, being a Report on the Experimental Work carried out during 1915 for the Zoological Society of London. By OLIVE C. LODGE*.

[Received March 29, 1916: Preliminary report read by Prof. H. MAXWELL LEFROY, November 9, 1915.]

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These experiments testing various substances on flies, were made with the object of finding out which were the most suitable to use as baits for traps, while others were tested as possible poisons. The work was undertaken under the direction of Prof. H. Maxwell Lefroy for the Zoological Society of London, during the summer and autumn of 1915.

The experiments in connection with Blow-flies were made in the Society's Gardens, Regent's Park; those on House-flies, at Acton Lodge, Brentford; while the work on poisons was done, for the most part, at the Imperial College of Science and Technology, South Kensington.

BAITS FOR BLOW-FLIES.

The well-known habits of blow-flies, and their attraction to dead and decaying animal matter, suggested three main lines of enquiry for experiment on blow-fly baits:—

- I. To try to find out whether any of the decomposition products or other organic compounds are attractive to blow-flies when isolated, and used as baits.
- II. To see which of the meaty substances are most attractive, when, and under what conditions.
- III. To experiment in a similar way with vegetable substances, to see if they are at all attractive.

The flies used in these experiments were those which were

* Communicated by Prof. H. MAXWELL LEFROY, M.A., F.Z.S.

most common at the Zoological Gardens during the early summer, viz. :—

- | | |
|---|---------------------------|
| (a) <i>Calliphora erythrocephala</i> and
" <i>vomitoria</i> | } The Blue-bottles. |
| (b) <i>Lucilia caesar</i> | |
| (c) <i>Protocalliphora grœnlandica</i> (released from breeding-cage). | The Green-bottle. |
| (d) <i>Musca domestica</i> | The House-fly (scarce) *. |
| (e) <i>Fannia canicularis</i> | The Lesser House-fly. |
| " <i>scalaris</i> | The Latrine-fly. |
| (f) <i>Piophilæ casei</i> | The Cheese-fly. |
| (g) <i>Sarcophaga carnaria</i> | The Flesh-fly. |

I. *Methods and account of experiments with various organic compounds.*

In these experiments the usual method adopted was to soak pieces of blotting-paper in the different substances to be tested, and to place them inside or outside the wire gauze breeding-cage (in which *P. grœnlandica* were bred). At the same time, controls consisting of similar pieces of blotting-paper soaked in water were placed beside each. The results were compared, and a note made as to whether the number of flies (if any) which came to the chemicals was equal to, greater, or fewer than the number which came to the controls.

The various substances used, classified according to their attractiveness, are given below (A–E).

A. *Substances found to be attractive to P. grœnlandica.*

Honey.	Fructose (solution in water).
Cane-Sugar molasses.	Lævulose " "
Beet " "	Cane-Sugar " "
Lactose (solution in water).	Urine (6 days old).
Maltose " "	" (16 days old).
Glucose " "	Uric acid.

B. *Substances found to be decidedly repellent.*

Pipendine.	Oil of Cinnamon leaf.
(Enanthol (weak).	" ; bark.
Xylol.	" Sassafras.
Oil of Thyme.	" Cloves.
" Cassia.	Camphor.
" Java Citronella.	Amyl acetate.
" Ceylon Citronella.	Methyl salicylate.
" Palma rosa.	Anisole.
" Bay.	Citral (strong).
" Heliotrope.	Ethyl sulphocyanide.
" Lavender.	

* Very few house-flies were seen in the Zoological Gardens during these experiments, probably because it was still early in the season for them; although they were never at all abundant there, even in August and September.

C. *Substances deterrent, though in a less degree than those given in B.*

Pyridine.	Carbon bi-sulphide.
p-Cresol.	Aniline.
Naphthaline.	Guaiacol.
Phenetole.	Toluene.
Hydrogen sulphide water.	Urethane.
Quinol.	Dimethylaniline.
Butyric acid.	Vanillin.
Carvone.	Ethyl acetate.
Quinoline.	Allyl sulphocyanate.
Anethole.	Ethyl nitrite.
Ammonia (weak).	Amyl nitrite.
Urine (fresh).	Lactic acid.
Borneol (in alc.).	Cedar-wood oil.

D. *Substances which gave no definite results.*

Methyl Iudol.	Methyl alcohol.
Indol.	β -Naphthol.
Pyrogallol.	Quinine sulphate.
Paraformaldehyde.	β Mono-methyl-uric acid.
Ammonium butyrate.	Trimeth. HCl.
" benzoate.	Acetal.
" valerate.	Uric acid (dry) + artificial musk.
α -Naphthaline.	Ethereal extract of horse-manure.
Skatol (strong).	NaOH " " "
" (dry).	Alcoholic " " "
Trimethylamine (weak).	HCl " " "
Urea.	Precipitate by HCl from NaOH
Tyrosine.	extract of horse-manure.
Guanine HCl.	Precipitate by NH_4OH from HCl
Betaine.	extract of horse-manure.
Dimethylamine.	

E. *Substances which gave the same results as the controls.*

Valeric acid.	Terpin OH (alc.).
Aspartic acid.	Potass. salicylate.
Formaldehyde.	Salicylic acid.
Tannic acid.	Ethyl formate.
Leucine.	Phenylacetic acid.
Stearic acid.	Caffeine.
Oleic acid.	Acetone.
Theobromine.	

Nothing of much practical value was obtained from these experiments. They gave, however, indications of the likes and dislikes of the flies (*P. grenlandica*), and so appeared useful in differentiating between the tastes of blow-flies; certain substances (A) were attractive, while others (B and C) were repellent or distasteful in varying degrees; others, again, gave no definite results (D) or the same results as the controls (E). Since these experiments were made with one species only, i.e., *P. grenlandica*, it does not follow that the results will be true for other

species also; in fact, subsequent experiments showed that tastes varied in different species of blow-flies, *e. g.*, honey and sugar were very attractive to *grænländica*, but not at all to *Lucilia* and *Calliphora*, although some of the substances gave similar results with the different species. The essential oils tested were found to be repellent to *grænländica*, and in those cases where tests were made with *Lucilia*, *Calliphora*, and *Musca*, they were seen to be repellent to them also. They may, therefore, be found useful as ingredients in sprays or unguents.

Experiments were also made to test the effect of certain organic compounds, etc., on house-flies*.

The following methods of testing them were employed:—

- (1) In which pieces of blotting-paper were soaked in them and exposed in sunny places in the greenhouse.

<i>Substances tested.</i>	<i>Results.</i>
Ammonium butyrate	Disliked by the house-flies.
„ benzoate	„ „ „
Amyl acetate	„ „ „
Methyl Indol	„ „ „
Trimeth. chlorhydrate .. .	„ „ „
Vanilla	„ „ „
α -Naphthaline	„ „ „
β -Naphthol	„ „ „
Ethyl sulphocyanide	„ „ „
Beet-sugar molasses	„ „ „
Urethane	„ „ „
Guanine HCl.	„ „ „
Guanadine HCl (+NaOH)	„ „ „
Trimeth. chlorhydrate (+NaOH)	„ „ „
Leucine	A few flies settled on this.
Artificial musk	Disliked by house-flies.

- (2) In which the substances were added to mixtures of casein, sugar, and water, and exposed for two days on the bench in the “fly-room” at the Imperial College (December).

All were harmless to the flies, nor were any as attractive as the controls.

A summary of results is given below:—

<i>Substances tested.</i>	<i>Results.</i>
$\left. \begin{array}{l} 12\cdot5 \text{ c.c. Casein + } \dots \\ 12\cdot5 \text{ c.c. Brown Sugar + } \dots \\ 12\cdot5 \text{ c.c. Water } \dots \end{array} \right\} = A. \quad \dots$	$\left\{ \begin{array}{l} \text{Very attractive throughout} \\ \text{whole experiment.} \end{array} \right.$
(Control)	
12 drops Safröl + A	Unattractive.
12 drops Santal + A	„ ; flies repelled at first.

* The account of these experiments testing certain organic compounds on house-flies is placed here, so as to be available for comparison with the similar experiments on blow-flies.

12 drops Hellibore + A	...	Not very attractive, non-poisonous.
12 drops Pyrethrum Extract (Alc.) + A	...	" " "
12 drops Xylol + A	...	{ Unattractive, until Xylol had evaporated, when flies came to feed.
6 drops Oil of Geraniol + A	...	
6 drops Oil of Thyme + A	...	{ Unattractive at first, later a few flies came. Repellent at first. Second day when smell of thyme less, a few flies came.
Bread soaked in water	...	
25 c.c. Casein +	...	{ = B } Very attractive.
25 c.c. Brown Sugar +	...	
25 c.c. Water	...	
(Control)	...	
12 drops Fuel Oil + B	...	Unattractive.
1 c.c. "Army Spray" + B	...	" , non-poisonous.

- (3) In which certain substances were tested against Bacterized Blood*. These experiments were made in the greenhouse in July. In some (a) a drop of the blood and another of the substance to be tested were placed on a piece of blotting-paper, side by side yet not touching, while in others (b) the two drops were mixed.

(a)	Vinegar.	{	Xylol.
	Propionic acid.		Methyl salicylate.
	Absolute alcohol.		Butyric acid.
	95 % "		Acetic "
	Anis "		
	Carvone.		
	Pyridine.		
	Oil of Cloves.		
	Formic acid.		
	Acetal.		

It was noticed that, generally, the house-flies disliked coming in contact with the chemicals, although they did not appear to detect them from a distance. They fed greedily at all places where they could get at the blood without touching the chemicals. A few flies, however, came for a short time to formic acid, methyl salicylate, butyric and acetic acids.

Xylol was distinctly repellent, but after it had evaporated the flies settled on the blood.

- (4) Other experiments were also made with Dried Blood, one day old, mixed with water and also with casein and sugar baits, etc. It was found to have no special attraction either for house-flies or blow-flies, apparently making no difference to an attractive bait, nor rendering an unattractive one attractive.

* This Bacterized Blood (*i.e.*, Blood prepared with putrefying Bacteria) was found by experiment to be very attractive to house-flies, and also when mixed with casein, sugar, banana, and water. Apparently it had no special attraction for blow-flies (*Lucilia* and *Calliphora*), either alone, or mixed with casein baits, with or without shredded meat.

11. *Methods and account of Experiments to find out when and under what conditions meaty substances are most attractive to blow-flies. (June and July.)*

All these experiments took place out of doors, the baits being exposed in sunny places in the Zoological Gardens; for it was found that even when a very attractive bait was placed in the shade, practically no blow-flies came to it, although they had been swarming round it when it was put in the sun.

The different substances were at first placed in shallow dishes, partially covered by glass plates, so that the flies could enter and feed, and the smell diffuse into the air. Later, however, it was found more convenient to use glass pickle-jars (height 9 inches, diameter 4 inches) fitted with wire-gauze funnels, which prevented the flies from escaping when once they had gone inside.

The number of flies caught in these jars was noted each morning and evening, but when dishes were used they were kept under as continuous observation as possible during the day, and the attractiveness of the bait estimated by the number of flies which had fed during that time.

The average length of time of each experiment was from six to seven days.

The first substances to be tried were meat and hard-boiled egg, of different ages. It was seen that after becoming blown their attractiveness was increased. This was especially the case when they had been kept for a few days, and were in a more or less liquid condition, owing to the digestive action of the maggots. At this stage they were very attractive to the blow-flies, the meat more than the egg, though numbers of flies came to both.

This effect of maggots on substances was further tested in later experiments, when two similar pieces of meat were put out side by side. To the one, maggots were added, while the other was kept covered with wire gauze to prevent flies getting to it and blowing it. It was moistened occasionally with water to prevent it from drying up. When both were similarly covered, blow-flies kept continuously buzzing round and settling upon the gauze covering of the former, while none or very few came to the latter.

Other substances were also tried, with like results, though their attractiveness without maggots varied with the different substances, and with the same substance at different stages.

Since this was seen to be the case, pepsin was tried to see if it acted in the same way. It was found, however, that both fish and meat after they had been acted upon by pepsin in the presence of hydrochloric acid, attracted fewer flies than did the controls of meat or fish alone. The flies used were chiefly *Lucilia*.

Peptone was also tried, both moistened with water and mixed with bread; sometimes maggots were also added*. A variety

* The maggots did not thrive in these mixtures. They appeared unhappy and restless, often escaping out of the dishes.

of flies came to these peptone baits, but not in very large numbers, i. e., a certain number of *Calliphora*, *Lucilia*, and *Fannia*, a few *Musca* and *Sarcophaga*, as well as many *Piophilæ*.

The blow-flies were always more attracted by meaty substances, although quite a number of them have been caught when mixtures of peptone were the only baits exposed.

Some of the different organs, as well as ordinary meat (muscle), and also dead birds, fish, etc., were used as baits. Of these, liver, brain, and fish were the most attractive, remaining so for a considerable time. Blow-flies very soon came to feed on these when exposed in sunny places, so that they became blown very quickly. When the digestive action of the maggots had had time to act upon the baits, they were extremely attractive, but gave off a most offensive smell. Since liver, brain, and fish were the most attractive of the meaty substances, they were tested against each other, in order to find out their relative attractiveness. First, the attractiveness of each for blow-flies was tested separately, when the mouths of two of the jars were closed by being covered by glass plates. Later, two at a time were left open, and finally all the three were left open together. Liver was then found to be by far the most attractive, although when fish and brain were exposed alone, they each caught a considerable number of flies.

Details and results are given below in Table I.

TABLE I.

Comparison of the Attractiveness for Blow-flies of liver, brain, and fish.

Liver (horse) + maggots (7 days old).	Fish (mackerel or whiting) + maggots (7 days old).	Brain (horse) + maggots (7 days old).
<i>Open.</i>	<i>Closed.</i>	<i>Closed.</i>
Very many flies caught.		
<i>Closed.</i>	<i>Open.</i>	<i>Closed.</i>
	Very many flies caught.	
<i>Closed.</i>	<i>Closed.</i>	<i>Open.</i>
<i>Open.</i>	<i>Open.</i>	Very many flies caught.
All the flies went here.	No flies came.	<i>Closed.</i>
<i>Closed.</i>	<i>Open.</i>	<i>Open.</i>
	Few flies came.	Many flies came.
<i>Open.</i>	<i>Closed.</i>	<i>Open.</i>
N o	R e c o r d.	
<i>Open.</i>	<i>Open.</i>	<i>Open.</i>
Very many flies came ; far more than to either of the others.	Hardly any flies came.	A certain number of flies came.

As a further test of the attractiveness of liver, another piece (three days old) was placed in the slaughter-house yard near a large trap baited with a horse's head. It was certainly attractive, catching about 400 flies* in 24 hours, showing that liver still attracted even amongst all the counter attractions of the slaughter-house yard.

The following lists (F-I) give the summary of the results from the experiments with the different meaty substances.

F. *Substances found to be most and continuously attractive to Blow-flies (Lucilia and Calliphora) †.*

Liver + maggots.
Meat + „
Brain + „
Fish + „
Hard-boiled eggs + maggots.

G. *Substances slightly attractive on first day, and also subsequently.*

Fish (under wire-gauze trap).
Boiled meat.
„ „ + maggots.
Marrow in bone.
„ „ + maggots.
Dead birds (mostly sparrows).

H. *Substances not attractive till second day, and then moderately so.*

Meat + pepsin + HCl.
Fish + „ + „
Meat + Methyl Indol.

I. *Substances unattractive to Blow-flies.*

Blood.
Bacterized blood, i.e. blood prepared with putrefying bacteria.
Fresh hard-boiled egg.
Fat.
Freshwater mussel (*Anodon*).
Hard-boiled egg + Methyl Indol.
Fresh meat + Skatol.
Unblown meat (covered by wire-gauze trap).
Alcoholic extract of putrid meat + bread.
„ „ „ „ + bread + maggots.
„ „ „ „ egg + bread.
„ „ „ „ + „ + maggots.

* The actual count was 138 *Lucilia*, + 49 *Calliphora*, + 51 *Fannia*, + 97 *Grænländica*, + 57 flies too damaged to recognize, + 4 which escaped. Total 396.

† In these and all subsequent experiments the blow-flies used were *Lucilia* and *Calliphora*. *P. grænländica* was only used in the first experiments, when it was still early in the season for the other species.

III. *Experiments with various fruit and vegetable baits.* (June-July.)

These experiments were carried out in the same way and under the same conditions as those on meaty substances. Shredded meat was sometimes mixed with the baits, but even then they were never so attractive to blow-flies as meat alone. None of the substances, even after they had been kept for a considerable time, were found to be at all attractive to blow-flies, though in some instances a few flies came to them. These substances are marked with an asterisk (*) in the following list:—

- Hay infusion.
- Boiled cabbage.
- Raw cabbage (cut up and moistened with water).
- Boiled lettuce.
- Raw " (cut up and moistened with water).
- Boiled grass.
- Grass + water.
- Boiled potatoes.
- Raw " (cut up and moistened with water).
- Water in which cabbage, lettuce, and grass had been boiled.
- Dates.
- " + water.
- Banana.
- * " + maggots.
- * " + " + meat.
- * " + meat.
- " + vinegar.
- Squashed strawberries.
- *Strawberries + meat.
- * " + " + maggots.
- " + yeast + "
- " + maggots.
- *Strawberry jam + meat.
- * " " + " + maggots.
- *Stinkhorn fungus (*Phallus*).

Further, certain household substances were used, such as bread and cheese, milk, vinegar, etc., as well as mixtures of casein, bread, and water, both with and without maggots.

The results are given below:—

<i>Baits.</i>	<i>Results.</i>
Treacle	Unattractive.
" + water	"
Brown sugar ...	"
" " + water	"
" " + " + meat	"
" " + " + yeast . .	"
Oxo + bread + water	"
" + " + " + maggots ...	"
Bread + vinegar	"
" + " + jam ...	"
" + " + " + maggots .	"

Baits.	Results.
Bread + cheese + milk	{ Few Blow-flies, <i>Fannia</i> , and many <i>Piophilæ</i> caught.
" + " + " + maggots ..	{ None caught till 2nd day, when flies (as above) caught.
" + " + water	{ 12 Blow-flies + 12 <i>Fannia</i> + 1 House-fly came on 1st day. Kept for 15 days and few caught each day.
" + " + " + maggots ..	{
Milk, fresh	Unattractive.
" sour	Few <i>Calliphora</i> caught.
Casein + water	{ <i>Fannia</i> + some Blow-flies and many <i>Piophilæ</i> caught.
" + " + maggots	{
" + " + bread	{ On 4th and 15th days many Blow-flies caught (when no meat baits exposed). On most days a few Blow-flies as well as <i>Fannia</i> and <i>Piophilæ</i> caught + a few <i>Musca</i> .
" + " + " + maggots .	{ <i>Musca</i> + <i>Lucilia</i> and <i>Calliphora</i> + few <i>Sarcophaga</i> + many <i>Piophilæ</i> caught—both at the Zoo and when put by manure-heap at Brentford.
" + " + "	{

Summary:—

It was found that for Blow-flies—

- (1) The most attractive baits were:—

- (a) Liver + maggots.
- (b) Brain + "
- (c) Fish + "
- (d) Hard-boiled egg + maggots.

Of these, liver + maggots gave the best results.

- (2) Meaty substances of all kinds were more attractive than either chemical or vegetable substances. More flies came to them than ever came to the vegetables or chemicals, even when these two latter were the only available baits for the flies; although certain substances, notably mixtures of casein and peptone with water and bread, showed possibilities of being good baits when they were the only attractions present. They then caught a number of different species (i. e. *Musca*, *Calliphora* and *Lucilia*, *Sarcophaga*, *Fannia*, and *Piophilæ*).
- (3) The digestive action of blow-fly maggots on meat, etc. added to their attractiveness.
- (4) The best way to attract and catch blow-flies was to put the baits in sunny places.
- (5) The great drawback, however, to the general employment of any of the meaty substances, or of the mixtures of casein, water, and bread, or of peptone, water, and bread, is the most objectionable smell which is given off when they have been kept for any length of time; yet it is only after keeping them thus that their most attractive stage is reached. It would, however, be possible to use them out of doors, in the garden, or elsewhere away from the house, where the smell would not matter so much.

BAITS FOR HOUSE-FLIES.

Methods and account of Experiments.

These experiments on house-fly baits were carried out at Acton Lodge, Brentford, during the latter half of July and in August.

The first experiments were made out of doors (*a*) near a manure-heap, from which flies were emerging, (*b*) in or near a forge, where a number of house-flies were congregating in the warmth.

In neither of these cases, however, were the conditions very favourable, chiefly on account of the wet and windy weather. Later, half a bushel of house-fly pupæ was collected from a neighbouring manure-heap, and placed in a greenhouse, where most of the subsequent experiments were made. This greenhouse was empty, excepting for some tomato-plants on the upper shelves (the flies did not like them, and would not settle or sit on the leaves). Ventilation was secured by nailing muslin over two of the windows. Very soon the greenhouse was swarming with flies, which had emerged from the pupæ. These flies were used in the experiments.

The supply of flies was kept up by breeding them in artificial media, consisting of mixtures of bread, casein*, water, and banana, and banana-skins, surrounded by a dry layer of cut grass, leaves, etc., in which the maggots could pupate; all of which were placed in large saucers on the floor, under the shelves. It was thus possible to keep up a continuous supply of flies.

In experimenting, the mixtures to be used as baits were placed in glass jars with wire-gauze funnels (the same as those used in the blow-fly experiments). The date and time of starting the experiment were noted, and usually a morning (9-11 A.M.) and evening (4.30-6.30 P.M.) count of flies taken, when the jars were emptied of flies and the dead (if any) removed.

The average duration of the experiments was 8-9 days.

The substances tested were very various. Mixtures of casein and peptone, which had seemed from the blow-fly experiments to be promising baits, were tried, as well as all sorts of other substances, *e. g.* sugars, jams, fruits, etc., both alone and mixed with casein and peptone. After some time it was found that the casein mixtures were more attractive than most of the other substances used. Hence experiments were made to try to discover when and under what conditions, and mixed with which substances these casein baits were most attractive. It was found that the best results were obtained with approximately equal parts of casein and brown sugar; or casein and banana; or

* The idea of using mixtures of casein, banana, etc. for breeding purposes was suggested by the fact that eggs were laid on some of the casein and banana baits in the jars, and that the larvæ lived in them. It was found very successful for breeding and keeping up a continuous supply of house-flies, both in this greenhouse and in the "fly-room" at the Imperial College. Flies were bred in large numbers from August 1915, and are still increasing (June 1916).

casein, banana, and brown sugar; or casein, banana, and golden syrup; or casein and bread—all of which were mixed with sufficient water to make into a paste. These mixtures, moreover, generally required a day or two in which to ripen before reaching their most attractive stage, which then lasted for a considerable time.

They were tested, amongst others, against the well-known recipe of beer and sugar, which was found to be immediately attractive, though it did not remain so for any length of time, only about two or three days. It was subsequently seen that the addition of beer, or preferably stout, to the casein, sugar, and banana mixtures, or to casein alone, made them immediately attractive, and that, when the effect of the beer or stout had gone off, the casein mixtures were themselves attractive and remained so for many days.

Several of these casein mixtures were also tested in the kitchen, but only a certain number of the flies were caught. This was probably due to the various counter-attractions present, though on one occasion * twenty house-flies were caught between 5 P.M. and 10 A.M. the next morning. This number was well over half the flies in the kitchen, though on other occasions fewer were generally caught. Yet these baits, even in the greenhouse, where as many as 600 have been caught in 6-7 hours, never by any means caught all the flies, but only a proportion of them. Other methods are likely to be found more effective in riddling kitchens of flies than the use of baited traps, *e. g.* spraying or fly-papers.

Other casein baits were also placed in different parts of the garden, as well as by the dust-bin, when various flies were caught, including *Musca*, *Calliphora*, *Lucilia*, *Fannia*, a few *Sarcophaga* and many *Borborus*; though more blow-flies were always caught with meat baits.

A summary of the results obtained from the experiments on House-fly Baits is given below (J-O). The substances are classified according to their attractiveness.

(N.B.—The days only are given on which the largest number of flies were caught. In most cases fewer flies were caught on the other days as well.)

(J) *Substances found to be the most attractive to House-flies.*

Baits.	Days on which most flies were caught (i.e. approximately 90-100 or more flies at each of the counts).
Casein + golden syrup + bread + water	9-10
„ + brown sugar + water ...	3-8
„ + bread + water	3-6
„ + brown sugar + dried blood + water ...	3-6
„ + „ „ + „ „ + „ + maggots .	1-4

* The bait consisted of casein + brown sugar + beer (3 days old).

Casein + bread + water	5-12
„ + brown sugar + water	3-6
„ + banana + water	1-6
„ + „ + brown sugar + water .. .	3-8
„ + golden syrup + brown sugar + water . . .	1-4
„ + white sugar + water	1-2
„ + „ „ + „ + Ale.	5-8
Beer + brown sugar	1-4
Casein + „ „ + stout	1-2
„ + „ „ + „	3-4 & 7-8
„ + stout	1-4 & 1-12
Brown sugar + stout	1-6
Casein + golden syrup + stout	3-8
Pudding (made of egg, gelatine, sugar and milk)	1-6
Horlick's Malted Milk + water *	1-6
„ „ „ + „ + banana „	3-4
Casein + banana + Malt Extract + water	5-6
„ + brown sugar + water	5-10
„ + „ „ + „ + bread	5-10
„ + golden syrup + bread + water	1-2 & 7-8
Cornflower + milk + sugar *	3-4
Bird's Custard Powder + white sugar + milk *	1-4
Boiled milk + white sugar + starch	1-2
Casein + brown sugar + water (boiled together)	1-2
Dutch cheese + brown sugar + water	1-2
Casein + water (boiled together)	3-6

(K) *Substances attractive, though in a less degree than those given in (J).*

<i>Baits.</i>	<i>Days on which most attractive (when approximately 60-80 flies caught at each count).</i>
Casein + brown sugar + water	3-4
„ + Alcohol + water	11-12
„ + Malt Extract	3-6
„ + bread + banana + water	3-4
„ + water (boiled together)	1-2
Toasted cheese	1-2
Casein + brown sugar + beer	1-2

(L) *Substances to which Flies still came, though never more than approximately 30-50 were caught at each count.*

<i>Baits.</i>	<i>Days on which the above number of flies were caught.</i>
Banana + maggots	5-6
Casein + „ + bread + water	11-12
Brown sugar + Alcohol + water	1-2
Casein + water	5-12
„ + brown sugar + beer	1-2
Horlick's Malted Milk + brown sugar + water	3-4
Bird's Custard Powder + boiled water	5-8

* Most of the flies died which fed on the three baits marked with an asterisk (*).

(M) *Substances to which Flies still came, though never more than about 20-30 were caught at each count.*

<i>Baits.</i>	<i>Days on which the above number of flies were caught.</i>
Casein + brown sugar + water	3-4 & 7-8
„ + white „ + „ + Alcohol	1-2
„ + golden syrup + „ + „	7-8
Boiled milk	1-4
Toasted casein + water	1-12
Casein + bread + „	4-6

(N) *Substances to which never more than about 10-20 came.*

<i>Baits.</i>	<i>Days on which the above number of flies were caught at each count.</i>
Golden syrup + alcohol	1-2
Brown sugar + „	1-2
Casein + brown sugar + water	1-10
„ + water	1-4
Boiled milk + white sugar	1-2
„ „ + stout	1-4
„ cheese + water	1-2
Dutch „	1-2

(O) *Substances unattractive to House-flies, and to which fewer than 10 flies at most came.*

<i>Baits.</i>	<i>Days exposed.</i>
Green treacle + bread	1-6
Golden syrup + „	1-6
Casein + green treacle + bread + water	1-6
Peptone + „ „ + „ + „	1-6
„ + golden syrup + „ + „	1-6
Casein + vinegar	1-6
„ + „ + yeast	1-2
„ + brown sugar + yeast + water	1-2
„ + vinegar + yeast + water	1-2
Peptone + toffee	1-4
„ + brown sugar + water	1-4
„ + „ „ + „ + yeast	1-4
Casein + toffee (cooked together)	1-4
„ + „ + maggots	1-4
Toffee + maggots	1-4
Casein + bread + water (at manure-heap)	1-4
„ + yeast + vinegar + maggots	1-4
„ + brown sugar + water	1-8
„ + golden syrup + „	1-12
Alcohol + water	1-4
Casein + brown sugar + water	1-6
Jam	1-4
Casein + Kepler's Malt Extract + water	1-8
Milk	1-8
„ + brown sugar	1-8
„ + Kepler's Malt Extract	1-8

Brown sugar + Kepler's Malt Extract	1-8
Malt Extract	1-8
Casein + water (boiled together)	1-8
„ + banana + water	1-4
„ + bread + „	1-6
Bird's Custard Powder + boiled milk	1-4
„ „ „ + „ water + brown sugar	1-8
Brown sugar + starch (boiled together)	1-12
Starch + boiled water	1-4
Casein + brown sugar + dried blood + water	1-8
„ + „ „ + beer + water	1-4
Condensed milk	1-6
„ „ + jam	1-6
Bread + Dutch cheese + water	1-6
“ Ridge's Food ” + water	1-5
„ „ + brown sugar + bread + water	1-5

The main conclusions arrived at from these experiments on house-fly baits were :—

- (1) That the most satisfactory baits consisted of—
 - (a) Mixtures of casein; sugar, or some other sweet stuff and water, with or without banana, in approximately equal proportions, to which stout or beer can be added, in which case they became immediately attractive, otherwise one or two days elapsed before the most attractive stage was reached *;
 - (b) Horlick's Malted Milk mixed with water;
 - (c) Banana, especially when over-ripe;
 - (d) Custard puddings;
 - (e) Cornflour, milk, and sugar;
 - (f) Bird's Custard Powder, milk, and sugar, etc. (*vide* list J).
- (2) There are advantages in using the casein mixtures rather than the other attractive baits in
 - (a) the comparative cheapness of casein (1s. 4d. per lb.) and
 - (b) the little trouble the baits take to prepare, the ingredients simply requiring to be mixed into a paste with a little water;
 - (c) the length of time they remain attractive (7-10 days as compared with the 2-3 days of beer and sugar);
 - (d) The absence of any disagreeable smell when the casein is mixed with sugar, golden syrup, banana, etc.†

* In November and December, however, the house-flies at the Imperial College came in swarms to feed on the casein mixtures as soon as they were placed on the bench. They even came to bread only. Was this because of the difference in the hunger-states of the flies at these different times, or were the casein mixtures more attractive when simply put out on the bench without being covered by a trap?

† Sugar, beer, alcohol, etc. had another advantage, as they appeared to preserve the baits from going mouldy, which often happened when casein was used alone, though this did not necessarily prevent them from being attractive. The great advantage was, however, that they kept them from giving off the most offensive smell which was the case when casein and water, and casein, water, and bread were used.

Yet in these experiments, at no time were all the flies caught, but only a proportion of them. This was, however, only to be expected, judging from the catholicity of their tastes; yet they have their likes and dislikes.

It was found that the attractiveness of most substances varied at different times. The weather appeared to influence them—as a rule fewer flies were caught on dull days than on sunny ones. Possibly, also, flies of different ages and sexes have different likes and dislikes, all of which would affect the numbers caught and the attractiveness of the baits.

III. POISONS FOR FLIES.

These experiments were made with the object of trying to discover a substance which would be poisonous to flies—especially house-flies—and harmless to man. It should not be distasteful to the flies, otherwise they will not come to feed, and unless cheap and easily obtained will not be suitable for general use.

The following methods of testing the different substances were employed:—

- (i.) To expose an attractive bait, to which the poison had been added, in a place where the flies were free to come and feed, or not, as they liked.
- (ii.) To test the poison on flies which were confined, and must either eat it or starve.

(i.) *Account of Experiments on Poison-baits when Free Flies were used.*

These experiments were carried out in the greenhouse. The flies used were chiefly house-flies, though a certain number of blow-flies from traps were released from time to time.

The substances used were generally placed in large saucers, in sunny places on the floor. They were then watched, to see whether after feeding, (a) the flies fell over immediately, apparently dead, or (b) crawled for a distance and then fell over on their backs, or (c) whether they flew away apparently unharmed. When the two former occurred, as many of the "corpses" as could be found were collected and kept till the next day, to see if they would recover.

It was thus possible to obtain some idea of the effect of the different substances on the flies, and also to see whether their addition made any difference to the attractiveness of the baits. They were generally added to mixtures of casein, banana, sugar, and water. Controls for comparison were arranged for each series of experiments.

A list of the various substances used, together with a summary of results, is given on p. 497.

<i>Substances tested.</i>	<i>Results.</i>
Borax	{ Did not poison house-flies or blow-flies. Made no difference in attractiveness of bait for house-flies, but were repellent to blow-flies.
Boric acid	
Picric acid (bait yellow)	{ Made no difference in attractiveness for house-flies or blow-flies: both fed greedily upon it, and were apparently unharmed!
Amyl alcohol	Strongly repellent to both house-flies and blow-flies.
Amyl acetate	{ Repellent to house-flies; but after the smell had gone off the baits were again attractive, and eggs were laid and larvæ lived in them. Flies were killed when it was poured into trap containing them.
Antimony oxide ...	
Acetaldehyde	Disliked by house-flies and blow-flies.
Westoran	{ Flies were killed when it was poured into trap containing them. Next day no apparent difference seen in attractiveness of baits.

Certain experiments were also made to test the poison-effect of paraformaldehyde and formaldehyde.

Some typical results are given in the table on p. 498.

It was not possible to arrive at any very definite conclusions from the above experiments with formalin, as the results were so varied. Sometimes the flies died after feeding on the mixtures, while at other times they were apparently unharmed. Some days they came in large numbers to feed, and on other days few or none came. Generally speaking, more seemed to come on fine than on dull days. One thing, however, seems clear, which is, that if formalin is used in practice for ridding rooms or buildings of flies, the "corpses" should be swept up and burnt as soon as possible, so as to prevent any possibility of recovery.

It was, however, felt that further and more accurate experiments should be made to test the poison-effect of formalin, etc., on house-flies, where known quantities of formalin were added to known amounts of bait. An account of these experiments is given below.

(ii.) *Account of Experiments on Poison-baits when House-flies were confined in cylinders.*

In order to secure more definite results than was possible in the greenhouse, the following experiments were made at the Imperial College of Science, in one of the laboratories, having an ordinary roof with no skylights. Thither the breeding-materials, maggots and pupæ from the greenhouse, were transferred. Very soon enormous numbers of flies had emerged, which were used in the experiments. The supply was kept up by breeding them in the same way as before.

The substances to be tested, placed on pieces of glass, were fed

Baits.	Results.		
	With Paraformaldehyde added.	With Formalin added.	Controls.
(A.) (a) Various casein, sugar, and banana mixtures placed in saucers in the greenhouse.	Made no difference to the attractiveness of bait to house-flies or blow-flies. Harmless to both.	<i>Used strong.</i> Repellent to house-flies and blow-flies. <i>Used weak.</i> Repellent to blow-flies, but house-flies seemed not to detect it until sufficient had been absorbed to kill them, or render them helpless. In no case were all of these latter found to be really dead, a certain number recovering after a time. In one case, out of the 600 picked up as dead, 21 % had recovered the next morning. The proportion of recoveries was often larger than this.	Attractive to house-flies, many of which fed—as well as some blow-flies.
(b) Meat .....	....	Repellent to blow-flies.	Attractive to blow-flies: very many came and fed.
(c) Custard Pudding.	.....	F. added while pudding hot. Very attractive to house-flies: very many fed, and soon died in and around the saucer.	Very attractive to house-flies.
(B.) Baits consisting of casein, sugar, and water were fed to house-flies enclosed in muslin cages in greenhouse.	(1) Flies still alive after three days, and then released. (2) Another lot kept for five days and then released as flies still alive.	.....	....
(C.) Balloon trap set over casein, sugar, and water mixtures in greenhouse.	... ..	Many house-flies came to feed, which were afterwards caught in balloon traps, where they were kept for two days and then released as flies still alive.	
(D.) Various casein, sugar, and water baits placed in jars with funnels in greenhouse.	Sometimes unattractive for many days: other times attractive on first day. Occasionally one or two flies died.	Generally attractive for one to three days. Many flies died.	Attractive: many flies caught. None died.

to house-flies enclosed in glass cylinders with muslin tops (height 8 inches, diameter 9 inches), which stood on the bench. When flies were needed for the cylinders, either they were taken from those caught in balloon traps set over the breeding-saucers, or pupæ were placed inside the cylinders to hatch out, etc.

In each experiment the following points were noted:—

- (a) the date and time of starting;
- (b) the source of the flies;
- (c) whether they came to feed at once;
- (d) the number of flies (if any) lying apparently dead on the bench, inside the cylinders, (1) after the first hour, (2) each morning and evening; and
- (e) whether any were feeding at those times.

The experiments usually lasted four days, as any substance which failed to kill by that time was considered useless. At the end of the experiment a count was made of the total number of males and females which had died, and also which had lived to the end of the experiment, when they were etherized before being counted.

The baits used were mixtures of casein, sugar, banana, and water; that most generally employed consisting of the following proportions:—

25 c.c. casein + 25 c.c. brown sugar + 25 c.c. banana.

- (a) If the poison was a liquid, it was simply mixed in with the casein etc.
- (b) If it was soluble, it was dissolved in 25 c.c. of water and added to the casein etc.
- (c) If it was insoluble, it was mixed with 25 c.c. of water and added to the casein etc.

Controls with clean baits—*i. e.*, 25 c.c. casein + 25 c.c. sugar + 25 c.c. banana + 25 c.c. water—were set up for each series of experiments: usually one control for all the experiments made on the same day.

Details of these experiments, with percentage of deaths etc., are given in Table II.

The results obtained from the experiments on poisons, when tested on house-flies enclosed in cylinders, were not very decisive (Table II.). No substance was found which killed a really large proportion of the flies. Tables III. and IV. respectively give the poison-mixtures having the largest percentage of deaths on the first day, and on the second day in cases when none had died before that. Substances which killed later than this, or where the death-rate was less than 10 per cent. on the first or second day, were not considered of much practical value. The highest percentage of deaths on the first day was only 31,

(Text continued on p. 514 at end of Tables.)

TABLE II.

Experiments on Poison-Baits for House-flies, with Flies confined in Cylinders.

Reference Number and Date of Starting.	Percentage of Formalin or other poison + Mixture (in Roman numerals)*.	Total number of Flies used, and Time of Starting Experiment.	Percentage of Flies which were lying on the bench, apparently dead, at different times, i. e. after first hour and in morning and evening.								Percentage of House-flies which died during experiment.		Remarks.
			Day 1. 1st hour. ...	Day 1. Rest of day. ...	Day 2. A.M. P.M.	Day 3. A.M. P.M.	Day 3. A.M. P.M.	Day 4. A.M. P.M.	Day 4. A.M. P.M.	Day 4. A.M. P.M.	♂	♀	
(6) 27.8.15	2 c.c. 40 p. c. F + i.	87 (p) × 4.0	...	...	30 [5th day, 99; 6th day, 100.]	68 ...	92 ...	97 ...	99 ...	100	100	0	0
(10) 28.8.15	5 c.c. 22 p. c. F + i.	75 (p) + 10.45	3, f	8	f [5th day, 95.]	51 ...	70	85	...	100	100	0	0
(7) 28.8.15	5 c.c. 20 p. c. F + i.	73 (p) + 10.45	8, s (12.45)	21	44, s [5th day, 99; 6th day, 99.]	...	83	84	...	108	97	0	3
(8) 28.8.15	5 c.c. 28 p. c. F + i.	84 (i. e. 66 (p) + 18 (ethl.))	4	11 [5th day, 63; 6th day, 71; 7th day, 84.]	21 ...	...	23	45	...	100	100	0	0
(9) 28.8.15	5 c.c. 27.6 p. c. F + i.	62 (i. e. 34 (p) + 28 (ethl.))	...	3	26 [5th day, —; 6th day, 100.]	...	65	71	...	100	100	0	0
(10) 28.8.15	5 c.c. 40 p. c. F + i.	87 (i. e. 51 (p) + 36 (ethl.))	8 (2.45)	14	23 [5th day, 100.]	...	55	79	...	100	100	0	0
(11) 28.8.15	5 c.c. Picric acid + i. (dissolved in 90 p. c. Ate.) (bright yellow).	87 (i. e. 77 (p) + 10 (ethl.))	0	0	0 [5th day, 98.]	4, f ...	40, f	69, f	...	100	95	0	5

* For full details of baits, see Key to Table II. on p. 517.

(12) 28.8.15	5 c.c. Picric acid + i. (dissolved in water) (yellow).	42 (p)	× 3.0	0	0 [5th day, —; 6th day, 24.]	0, f 0 (dry)	4	21	...	67	29	33	71
(13) 28.8.15	2 c.c. 40 p. c. F + i.	84 (i. e. 64 (p) + 20 (c.h.))	× 3.0	0	...	12 [5th day, —; 6th day, 100.]	51 (dry) 65	75	...	100	100	0	0
(14) 28.8.15	2 c.c. 40 p. c. F + i. (part on glass and part in dish).	73 (p)	× 4.0	4 (4.20)	5 (4.45)	... (1.30) 33 [5th day, 100.]	48 (dry)	86	...	100	100	0	0
A(16) ¹⁴ 28.8.15	iii.	87 (p)	+ 1.45	6, f (2.0)	9	17, f (dry) [5th day, 95.]	33 48	60	...	93	57	7	43
A(16) ¹⁴ 28.8.15	iv.	63 (p)	2.0	16, f (3.20)	..	21 [5th day, 83.]	33 54 (dry)	68	...	95	74	5	20
A(17) ¹⁴ 28.8.15	28 p. c. F + v.	86 (i. e. 65 (p) + 21 (c.h.))	÷ 3.0	17 (4.45)	17	20 35	37	58	74	90	64	10	36
A(18) ¹⁴ 28.8.15	36.7 p. c. F + v.	82 (p)	× 3.30	11 (4.15)	15 (4.45)	20 [5th day, 71.]	29 41, f	60, f (dry)	...	69	71	31	29
A(19) ¹⁴ 28.8.15	32 p. c. F + v.	67 (p)	3.45	0	0	6, f [5th day, 51.]	15 22	40, f (dry)	...	64	43	36	57
A(20) ¹⁴ 28.8.15	29 p. c. F + v.	70 (p)	× 4.15	24 (4.35)	27 (4.45)	40	41, f 55	71	81	91	73	9	27
Control A(21) ¹⁴ 28.8.15	W + v.	78 (i. e. 38 (p) + 40 (c.h.))	× 4.30	0, m (4.40)	0, f	0, f 1, f	1, f 1, f	1, f	1, f	[1]	[99]		
B(22) ¹¹ 30.8.15	40 p. c. F + vi.	87 (p)	11.15	7 (11.40)	14	24	...	46, f	40, f	80	31	40	60

No record of the sexes.

TABLE II. (continued).

Reference Number and Date of Starting	Percentage of Formula or other poison + Mixture (in Roman numerals)	Total number of Flies used, and Time of Starting Experiment.	Percentage of Flies which were lying on the bench, apparently dead, at different times, i. e. after first hour and in morning and evening.								Percentage of House-flies ($\delta + \sigma$) which died during experiment.		Remarks.
			Day 1.		Day 2.		Day 3.		Day 4.		δ	σ	
			1st hour.	Rest of day.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	δ	σ	
I(23) ¹ 30.8.15	36.7 p. c. F + vi.	63 (p)	+11.40	6, f (11.50)	27	...	44, f	71	79	66	6	34	
I(24) ¹ 30.8.15	32 p. c. F + vi.	74 (p)	11.45	16 (12.5)	43	...	64	73	84	86	6	11	
I(25) ¹ 30.8.15	30.5 p. c. F + vi.	61 (p)	* 11.55	15 (12.15)	(5.45) 31	33	56	69	84	73	7	27	
I(26) ¹ 30.8.15	20 p. c. F + vi.	71 (p)	12.15	1	14	18, f	35, f	46	58	51	26	19	
I(27) ¹ 30.8.15	27.5 p. c. F + vi.	61 (p)	12.20	15, f	16	26	48	51	77	64	21	36	
Control I(28) ¹ 30.8.15	W + vi.	90 (p)	× 12.30	0	0, f [5th day, 0; 6th day, 0]	0, s	0, s	0, s	0, s	0	100	100	
I(29) ¹ 30.8.15	W + vi. + (40 p. c. F in another dish, covered with muslin).	82 (p)	× 12.55	m, 0	0, f	0	1, f	2, f	6, f	[3]			Actual numbers of dead given; percentage impossible, as sex of survival not recorded.
I(30) ¹ 30.8.15	24 p. c. F + vi.	86 (p)	3.30	10 (3.35), f	22	19, f	37, f	72, f	98	95	0	5	
I(31) ¹ 30.8.15	30 p. c. F + vi.	74 (p)	× 4.0	11 (4.10), f	19	35, f	54, f	66, f	95	93	3	7	

(32) ¹ 30.8.15	25.5 p. c. F + vi.	86 (p)	× 4.0	13 (4.25)	12	23, f	...	48, f	62, f	91	..	100	82	0	18
(33) ¹ 30.8.15	30 p. c. F + vi.	84 (p)	× 4.10	7, m (4.25)	...	32	...	61	71, f	94	..	76	91	21	9
(34) ¹ 30.8.15	vii.	75 (p)	× 5.15	0, m	...	1, f	...	40, f	68, f	92		95	88	5	12
(35) ¹ 31.8.15	1 c.c. Chloral hydrate + viii.	78 (p)	× 11.0	0		5 [5th day, 9, f; 6th day, 9.]	...	8 day, 9.]	...	9, f		23	9	77	91
(36) ¹ 31.8.15	5 c.c. Chloral hydrate + viii.	19 (p)	÷ 11.45	0		0 [5th day, 10; 6th day, 21.]	...	5 day, 21.]	...	11	11	35.5	9	72.5	91
(37) ² 1.9.15	1 c.c. Pepper mixed with viii. + a little dusted on top of bark.	(About 40 (p)	÷ 10.45	0	0	0 [5th day, 0.]	0	0	0, f	0	0, f	0	0	100	100
(38) ² 1.9.15	1 c.c. Zn. Sulph. Carb., + viii. (dissolved in little water).	31 (p)	11.15	-0	0	0 [5th day, 0.]	0	0	0	0	0	0	0	100	100
(39) ² 1.9.15	1 c.c. Calomel + viii. (half mixed in and half dusted over).	47 (p)		...	2	2 [5th day, 13.]	6	6	4, f	6	...	4	25	96	75
Control (40) ² 1.9.15	viii.	53 (p)	12.5	10, f	0, f	0, f [5th day, 2.]	2, f	2, f	2, f	2, f	2, f	0	2	100	98
(11) ² 1.9.15	2 c.c. Quillaia Bark + viii. (in 10 c.c. Alc.).	31 (fl)	3.20	0, f (at edges)	3	6, f [5th day, 13.]	6, f	6, f	6, f	6, f	6	17	11	83	80
(12) ² 1.9.15	2 c.c. Acetal + viii.	56 (fl)	÷ 3.30	0	0	2, f [5th day, 2.]	2, f	2, f	2, f	2, s	2	0	2	100	98

TABLE II. (continued).

Reference Number and Date of Starting.	Percentage of formalin or other poison + Mixture (in Roman numerals).	Total number of Flies used, and Time of Starting Experiment.	Percentage of Flies which were lying on the bench, apparently dead, at different times, i. e. after first hour and in morning and evening.										Percentage of House-flies which died during experiment.		Percentage of House-flies which lived to end of experiment.		Remarks.
			Day 1. 1st hour.	Day 1. Rest of day.	Day 2. A.M. 1, s [5th day, 1.]	Day 2. P.M. ..	Day 3. A.M. 1, f	Day 3. P.M. ...	Day 4. A.M. 1, f	Day 4. P.M. 1, f	♂	♀	♂	♀	The flies are survivors from A(21).	The 66 flies used in this experiment were those from B(20).	
(43) ² 1.9.15	2 c.c. Ethyl formate + viii.	77 (p) × 3.50 + (eth y)	0, f	0	11, f	17, f	33, s	44, s	44, f	50	67	32	33	68			
(45) ² 1.9.15	1 p. c. F + vi.	46 (H)	0, f	0, f	0, f	0, f	0, f	0, f	0, f	0, f	0	0	100	100			
Control (46) ³ 2.9.15	W + vi.	v (H)	0, f	[5th day, 0, f;	0, f	0, f	0, f	0, f	0, f	0, f	0	0	100	100			
(47) ³ 2.9.15	5 p. c. F + vi.	26 (H)	12 (11.45)	15 (2.45)	19	38	46, f	65	73, f	81	100	74	0	20			
(48) ³ 2.9.15	10 p. c. F + vi.	54 (H)	0	(2.45) 2, f	15, f	46, f	61, f	69, f	78, f	85	100	78	0	22			
(49) ³ 2.9.15	1 p. c. CaSO ₄ + vi. (pale green).	66 (H)	2 (3.40)	3, f	3	3, f	3, f	3, f	3, f	3	5	0	95	100			
(50) ³ 3.9.15	1 p. c. Kl. + vi.	47 (H) × 3.40	0, f	0, f	0, f	0, f	0, f	0, f	0, f	0, f	5	4	95	96			
(51) ³ 3.9.15	2 c.c. Carvone + viii.	91 (H) + 10.0	0 (2.30) 4	(5.15) 10	18, f	36, f	55, f	59, f	71	...	92	44	8	56			
(52) ³ 3.9.15	1 c.c. 1 p. c. Nic. + iv.	40 (H)	0, f	0	0, f	0, f	0	0	0	0	0	0	100	100			

	90 (n)	$\times 11.0$	O, s	O, s	$\frac{O,f}{(+5 \text{ drops Pyrid.})}$ [5th day, O (+1 c.c. Pyrid., + new bait) O.]	$\frac{O,f}{(+6 \text{ drops Pyrid.})}$ + new bait O.]	0	O, f	0	8	93	100
(53) ³ 3.9.15	1 drop Pyrid. + ix.											
(54) ³ 3.9.15	2 c.c. Trimeh. + iv.	$\times 12.30$	4 (2.0)	4, f	$\frac{O,f}{(+5 \text{ drops Pyrid.})}$ 4, f	$\frac{O,f}{(+6 \text{ drops Pyrid.})}$ 4, f	6		7		93	92
(55) ³ 3.9.15	5 c.c. Abs. Alc. + iv.	$\times 2.45$	0, m	0, f	0	[1]	[1]	.	[1]	0	P	100
(56) ³ 3.9.15	2 c.c. Amyl Alc. + ix.	+ 5.0	0	0	0	0, f	0	0	0	0	100	100
(57) ⁵	1 grm. Pot. Salic. + viii.	$\times 11.45$	15 (12.15)	27, f	36	55, f	67, f	70, f	82	84	78	16
(58) ⁵ 3.9.15	1 grm. Tannic Acid + viii. (light brown).	$\times 11.45$	5, s (12.26)	23, f	23, f	23, f	23, f	28, f (dry)	28	[8]	[0]	[13]
(59) ⁵ 4.0.15	x. (mst.).	$\times 12.25$	0, f	0, f	[1] f	[1] f	[4] f		[6]	[3]	[:]	
(60) ⁵ 4.0.15	1 grm. Salic. Acid + xi.	$\times 12.25$	0, m	2	10, f	16, f	62, f	74	72	86	69	14
(61) ⁵ 4.0.15	5 grm. Caff. + xi.	12.50	0	0, f	3, f	9, f	20, f	32, f	62, f	100	41	0
(62) ⁵ 4.0.15	1 grm. Pot. salic. + viii. (brownish green).	$\times 3.40$	0, f	0	7, f	22	44, f	59	82, f	100	80	0
Control 4.0.15	viii.	4.0	0, s	0, s	0, f	0, f	0	0, s	0, s	100	94	0

TABLE II. (continued).

Reference Number and Date of Starting.	Percentage of Formalin or other poison + Mixture (in Roman numerals).	Total number of Flies used, and Time of Starting Experiment.	Percentage of Flies which were lying on the bench, apparently dead, at different times, i. e. after first hour and in morning and evening.								Percentage of House-flies ($\delta + \varphi$) which died during experiment.		Percentage of House-flies ($\delta + \varphi$) which lived to end of experiment.		Remarks.
			Day 1. 1st hour. Rest of day. (5.15) 3	Day 2. A.M. 3 P.M. 7 [5th day, 8.]	Day 3. A.M. 3, f P.M. 7, f [4, f day, 7.]	Day 4. A.M. 6, f P.M. 8, f	δ	φ	δ	φ					
(61) ⁶ 4.9.15	1 p. c. Picric acid + vi.	36 (fl) × 3.15	0	4 [5th day, 7, f; 8th day, 7.]	7, f	7, f	0	[1]	0	100	..				1 φ died, percentage impossible since sex of survivors unknown.
Control (65) ⁶ 5.9.15	viii.	28 (fl) × 3.30	0	7 [5th day, 7, f; 8th day, 7.]	7, f	7, f	0	[1]	0	100	..				
(66) ⁶ 5.9.15	1 p. c. Cu Acetate + vi.	39 (fl) × 3.40	0	0 [5th day, 3.]	3, f	3, f	0	3	0	100	97				
(67) ³ 6.9.15	2 c.c. Citric acid + viii.	60 (fl) × 2.30	0	0, f	2, f	2	2	0	2	97	100				
(68) ⁵ 6.9.15	1 c.c. Chromic acid + ix. (bright yellow).	49 (fl) × 2.40	0, s	0, f	8, f	40, f (dark brown).	94	92	100	0	8				
(69) ³ 6.9.15	2 c.c. Lead chromate + xi. (bright yellow).	29 (fl) ÷ 3.0	0	0, s	0, f	0, s	0	0	0	100	100				
(70) ⁵ 6.9.15	2 c.c. Red Lead + xi. (bright red).	39 (fl) × 3.30	0, s	0, s	0, f	0, f	0, s	0	0	100	100				
(71) ³ 6.9.15	2 c.c. Lead acetate + viii.	47 (fl) × 3.40	0, s	0, f	0, f	0, f	0	0	0	100	100				
(72) ⁵ 6.9.15	2 c.c. Lead nitrate + viii. (inst.).	83 (fl + p) × 3.55	0, s	0, f	1, s	13, s	23, m	35	56	44	65				

(73) ⁵ 6.9.15	1 c.c. Amyl acetate + ix.	33 (fl)	5.15	0	0	0, f	0	0, s	0, f	3	3	12.5	0	87.5	100	The 39 flies used in this experiment were those from (70).
(76) ⁵ 9.9.15	2 c.c. Lead Carb. + xi.	30 (fl)	× 11.0	0, f	0	0 [5th day, 0.]	0	0	0	0 (dry)	0	0	0	100	100	
(70) ⁸ 10.9.15	2 c.c. Meth. salic. + ix.	16 (fl)	+ 11.45	0	0 [5th day, 0; 6th day, 0.]	0	0	0	0	0	0	0	0	100	100	
Control (80) ⁸ 10.9.15	W + vi.	29 (fl)	× 10.30	0, s	0, f	0, f	0, f	0, f	0, f	0, f	0	0	0	100	100	
(81) ⁸ 10.9.15	5 c.c. KClO ₃ + viii.	x (p)	× 2.30	0	0, f	0, f [5th day, 0, m.]	0, f	0, f	0, f	0, f	0	0	0	100	100	
(82) ⁸ 10.9.15	2 c.c. (f) BaSO ₄ + xi.	28 (p) (Flies from (65)).		0, s	0 [5th day, 0, dry; 6th day, 7.]	0, f	0, f	0, f	...	0, f	0	0	0	100	91	
(83) ⁸ 10.9.15	1 p. c. NaOH + vi.	18 (fl + p) × 3.20		0, f	0 [5th day, 0, dry; 6th day, 0 (mld.)]	0	0	0	0	0	0	0	0	100	100	
(85) ⁸ 10.9.15	5 grms. NH ₄ NO ₃ + viii.	19 (fl)	4.20	0	53 [5th day, 89; 6th day, 100.]	53	58	58	..	74	74	100	100	0	0	
(86) ⁹ 13.9.15	5 c.c. Oil of Turp. + ix.	0 (fl)	+ 11.50	0	0	0	0	0	..	..	..	0	0	100	100
Control (89) ⁹ 15.9.15	W + vi.	x (p*)	11.30	0, f	0, f [5th day, 0; 6th day [1]; 8th day [3].]	0	0	0	0	0	0	[2]	[7]	These are actual num- bers of deaths. Percentage impossible as total num- ber of flies unknown.
(92) ⁹ 16.9.15	xii. (Pyrethrum).	48 (p*) × 1.15		0, m	0, f [5th day, 0.]	0, f	0, f	0, f	0, f	0	0	0	0	100	100	

TABLE II. (continued).

Reference Number and Date of Starting.	Percentage of Formalin or other poison + Mixture (in Roman numerals).	Total number of Flies used, and Time of Starting Experiment.	Percentage of Flies which were lying on the bench, apparently dead, at different times, i. e. after first hour and in morning and evening.								Percentage of House-flies which died during experiment.		Remarks.
			Day 1. 1st hour. 0, s	Day 1. Rest of day. ..	Day 2. A.M. P.M. 0 [5th day, 0.]	Day 2. A.M. P.M. 0 ..	Day 3. A.M. P.M. 0 ..	Day 3. A.M. P.M. 0, f	Day 4. A.M. P.M. 0	Day 4. A.M. P.M. 0	♂	♀	
(93) ⁹ 16.9.15	2 c.c. Household Ammonia + ix.	13 (fl*) × 11.15	0, s	...	24	..	24	24	28	0	100	100	
(94) ⁹ 16.9.15	1 grm. Oxalic acid + viii.	29 (fl*) × 12.20	0, s	...	24	..	24	24	28	43	57	83	
(95) ⁹ 16.9.15	2 grms. KBr + viii.	35 (fl*) 2.35	...	...	17, s	...	57, f	20, f	..	78	22	45	
(98) ⁹ 16.9.15	2 grms. KI + viii.	x + 15 (fl) × 3.30	0, s	0, f	0 [5th day [15].]	...	[1] f	[2] f	..	[8]	...	..	These are the actual deaths, percentage impossible as total number of flies unknown.
(99) ¹⁰ 20.9.15	2 grms. Oxalic acid + viii.	x + 4 (fl) + 10.20	0	0	0	...	0	[4]	...	[1]	...	...	Ditto.
(100) ¹⁰ 20.9.15	To be starved.	x (fl. fed 10.20 one day on clean bait).	0	0	0	...	0	0	..	0	100	100	
(101) ¹⁰	5 grms. KBr + viii.	x (fl) × 10.45	0	0, f	0, f	...	3	..	..	0	100	..	Ditto.
(102) ¹⁰ 20.9.15	10 grms. NH ₄ NO ₃ + viii.	x (fl) 11.30	0	0	[4] f	..	[10]	..	...	[3]	...	...	Ditto.
(108) ¹⁰ 20.9.15	5 grms. Na ₂ CO ₃ + viii.	x (fl) × 11.45	0	0	0	...	0	..	..	0	100	100	

(101) ¹⁰ 20.9.15	5 grms. White Lead + xi.	x (fl)	×12.10	f	0	0	...	0	...	..	0	0	100	100	{ 5 flies found to have died from <i>Empusa</i> <i>musae</i> ; these are in- cluded in percentage for columns 1-5, but not calculated in percentage of dead and survivors.
(105) ¹⁰ 20.9.15	1 c.c. Carvone + 2 iv. (kept for 3 days before fed to flies).	14 (fl)		.	0	0, f [5th day, 50.]	7	14	35.3	100	0	35.3	100	66.7	{ These are actual deaths, percentage impossible as total number of flies un- known.
(106) ¹⁰ 20.9.15	5 c.c. Chromic acid + viii. (kept for 3 days before fed to flies).	8 (fl)		..	...	12.5, f [5th day, 87.5.]	50	75	[3]		[1]	[3]			{ These are actual deaths, percentage impossible as total number of flies un- known.
(107) ¹⁰ 20.9.15	1 grm. Camphor + xi.	x (fl)	×12.45	0, s		0	..	0	0	100	0	0	100	100	
(108) ¹⁰ 20.9.15	1 c.c. Amyl nitrite + ix.	x (fl)	÷ 1.50	0	..	0	..	0	0	100	0	0	100	100	
(Control) (109) ¹⁰ 20.9.15	W + vi.	x (fl)	4.45	0	...	0	..	0	0	100	0	0	100	100	
(110) ¹⁰ 22.9.15	10 grms. NH ₄ NO ₃ + viii. (inst.).	x (fl)	×11.10	0, f	(4.10) [2]	...	..	..	..	..	[1]	[1]	..	..	{ These are actual deaths, percentage impossible as total number of flies unknown.
(112) ¹¹ 23.9.15	5 grms. KI. + viii.	17 (fl)	× 1.10	0	0	0 [5th day, 94.]	35	47	90	0	100	90	0	10	{ 4 flies found to have died from <i>Empusa</i> <i>musae</i> ; they are in- cluded in percentage in columns 3-7, but not in last two.
(113) ¹¹ 23.9.15	5 grms. KBr + viii.	16 (fl)	1.15	.	..	19, f [5th day, 100.]	87.5	87.5	100	0	100	100	0	0	
(114) ¹¹ 23.9.15	10 grms. NH ₄ NO ₃ + viii.	8 (fl)	2.30	0	0	0	37.5	87.5	100	0	100	100	0	0	
(Control) (115) ¹¹ 24.9.15	viii.	10 (fl)		0	0	0 [5th day, 80.]	0	1	66.5	0	100	66.5	0	33.5	

TABLE II. (continued).

Reference Number and Date of Start ing.	Percentage of formula on other poison + mixture (in Roman numerals).	Total number of Flies used, and Time of Starting Experiment.	Day 1. 1st hour. Rest of day.	Day 2. A.M. P.M. 13 47 f [5th day, 81.]	Day 3. A.M. P.M.	Day 4. A.M. P.M. 81 95	Percentage of House-flies (♂ + ♀) which died during experiment.	Percentage of House-flies (♂ + ♀) which lived to end of experiment.	Remarks.
(116) ¹¹ 24.9.15	2 grms. Sb-oxychl. + vi.	19 (fl) × 11.5	Day 1. 1st hour. Rest of day.	13 47 f [5th day, 81.]	...	81 95	♂ 80 ♀ 75	♂ 20 ♀ 25	1 fly died from <i>Empusa musca</i> . It is included in percentage of columnus 3-7 only.
(117) ¹¹ 24.9.15	5 c.c. Adren. HCl. + ix.	15 (fl) × 11.15	2 (2 15)	13 f 7 f [5th day, 81.]	27	27	33.3 20	66.7 80	Ditto.
(118) ¹¹ 25.9.15	To be starved.	16 (fl) 11.20		6 (3.30) 19 44 [5th day, 91.]	..	69	♂ 51 ♀ 7	.	{ These are the actual deaths, percentage impossible as sex of survivors unknown.
(119) ¹¹ 24.9.15	3 drops Ethyl SCN + ix.	17 (fl) 11.25	11 (2.15) + 12 (th)	82 71 65 [5th day, 65.]	..	53	100 86	0 14	{ It was seen in other experiments that it was the Ethyl sulphocyanide vapour which "killed" the flies. They fell over apparently dead almost as soon as the bait was fed to them, and before any had eaten at all. If it was removed after a few minutes, they all recovered again.
(120) ¹¹ 24.9.15	5 drops Allyl Sulpho- cyanate + ix.	x (fl) 2.15 0	0	0 0 0 [5th day (9).]	..	[0]	0 0	100 100	1 ♀ died. Percentage impossible as total number of flies unknown.
(121) ¹¹ 25.9.15	xiii.	x (fl) 12.10 0	0	0 0 0	0	[1]	0 .	100 ..	One fly died of <i>Empusa musca</i> ; it is not counted in percentage.
(122) ¹¹ 25.9.15	xiv.	x fl 2.10 0	0	0 0 0	[0]	[0]	0 0	100 100	

(126) ¹¹ 27.9.15	5 grms. Sb-oxychl. + xi.	8 (fl) (i.e. 6+2 stb.)	11.55	...	0	25	37.5	37.5	50	100	20	0	80
(127)	2 c.c. Mustard Oil. + ix.	5 (fl)	×11.55	0, f	0	0	25	25	25	0	33.3	100	66.7
(128) 28.9.15	Br. + xv.	7 (fl)	2.45	0	0	0	0, f	0	0	0	0	100	100
(129) 28.9.15	xvi.	4 (fl)	2.15	0	0	0	...	...	0	0	0	100	100
(130) 28.9.15	Br. + xvii.	5 (fl)	÷ 3.50	24 (4.15)	(5.30) 60	0	60 (11)	0, s	...	0	0	100	100
Control (133) ¹² 2.10.15	vii.	x (q')	11.45	0	0	...	...	0	0	[3]	...	...	...
(136) ¹²	To be starved.	x (q)		0	0	0	[5th day, All.]	[4]	[20]	100	100	0	0
(137) ¹² 4.10.15	1 c.c. Acetaldehyde + ix.	x (p)	×11.15	0, f	...	0	0	0	...	0	0	100	100
(138) ¹² 4.10.15	2 c.c. Dimethan. + ix.	x (p)	÷11.30	0	0	0	0	0	...	0	0	100	100
(139) ¹² 1.10.15	2 c.c. Butyric acid + ix. (inst.).	x (fl)	11.45	0	0	0	0	0	...	0	0	100	100
(141) ¹² 4.10.15	5 c.c. Iodine + ix. (greenish yellow).	x (fl)	3.35	0	0	0	0	0	...	0	0	100	100
(142) 8.12.15	To be starved.	39 (fl*)	10.0	...	3	...	82	95	100	100	100	0	0
29.12.15	To be starved.*	4 (fl)	4.30	0	0	0	0	0	0	50	[0]	[100]	...

These are the actual
deaths, percentage impos-
sible as total number of
flies unknown.
Ditto.

Unfortunately sex not
noted.

* These four house-flies were caught in Refreshment Room on Rugby Station. They were put in a glass tube and kept in a room with a temperature of 15°-50° F.

TABLE III.

Poisons which killed largest percentage of Flies on first day.

Order.	Ref. No. in Table II.	Baits. (For full details, see Key to Table II., p. 517.)	Percentage of pure poison in whole mixture.	Percentage of Flies which died on first day.
1.	25	25 c.c. 30 p. c. Formalin + vi.	7.5	31
2.	24	25 c.c. 32 p. c. " + vi.	8	27
	20	25 c.c. 29 p. c. " + vi.	7.5	27
	57	1 grm. Potass. salic. + viii.	1	27
3.	58	1 grm. Tannic acid + viii.	1	23
4.	23	25 c.c. 36 p. c. Formalin + vi.	9	22
	30	25 c.c. 24 p. c. " + vi.	6	22
5.	7	5 c.c. 29 p. c. " + i.	5	21
6.	31	25 c.c. 36 p. c. " + vi.	9	19
7.	17	25 c.c. 28 p. c. " + v.	7	17
8.	27	25 c.c. 27.5 p. c. " + vi.	6.9	16
9.	47	5 c.c. 5 p. c. " + vi.	1.25	15
	18	25 c.c. 36 p. c. " + v.	9	15
10.	10	5 c.c. 40 p. c. " + i.	7	14
	22	25 c.c. 40 p. c. " + vi.	10	14
	26	25 c.c. 29 p. c. " + vi.	7.25	14
11.	32	25 c.c. 25.5 p. c. " + vi.	6.3	12
12.	51	2 c.c. Carvone + viii.	2	10

TABLE IV.

*Poisons which killed largest percentage of Flies on second day,
when none had died on first day.*

Order.	Ref. No. in Table II.	Baits. (For full details, see Key to Table II., p. 517.)	Percentage of pure poi-on in whole mixture.	Percentage of Flies which died on second day.
1.	5	2 c.c. 40 p. c. Formalin + i. a.	2	66*
2.	85	5 grm. NH_4NO_3 + viii.	5	53
3.	116	2 grm. Sb. oxychl. + xi.	2	47*
4.	84	25 c.c. 40 p. c. Formalin + vi.	10	45
5.	128	5 grm. Sb. oxychl. + xi.	5	37.5
6.	68	1 c.c. Chromic acid + viii.	1	31
7.	94	1 grm. Oxalic acid + viii.	1	24
8.	62	1 grm. Potass. salic. + viii.	1	22
9.	118	Starved Flies.	—	18
10.	95	2 grm. Potass. bromide + viii.	2	17
	45	25 c.c. 1 p. c. Formalin + vi.	0.25	17
11.	19	25 c.c. 32 p. c. " + v.	8	15
12.	13	2 c.c. 24 p. c. " + i.	2	12

* No record was made on the first day in these two experiments. It is therefore not known whether any flies died then or not.

TABLE V.

Details of Experiments when Poison-baits were fed to House-flies, and Clean-baits to Survivors; showing percentage of Deaths, etc., amongst Original Flies and Survivors, as well as in Starved Flies and Controls.

Poison-baits, (For full details see Key to Table II.)	Total number of Flies used in Expt.	Total length of time Flies were given Poison- bait.	Percentage of Deaths from Poison-bait.		Total number of Flies which survived.	Total length of time survivors were given clean bait.	Percentage of deaths amongst survivors with clean bait.		Average death-rate per diem.	
			(a) On 1st day.	(b) During whole time.			(a) On 1st day.	(b) During whole time.	(a) Amongst origl. flies.	(b) Amongst survivors.
Carbure + n.	45	5 days	4 p.c. (after 4-6 hours)	33 p.c.	30	5 days	0 p.c. (1st deaths on 2nd day, when 7 p.c. died.)	11 p.c.	7 p.c.	3 p.c.
Chromic Acid + vin.	23	3 "	0 p.c. (" 2-3 ")	43 p.c.	13	5 "	0 p.c. (1st deaths on 3rd day when 46 p.c. died.)	61 p.c.	14 p.c.	12 p.c.
10 p.c. Formalin + vi.	14	1 "	14 p.c. (" 7 ")	28 p.c.	10	3 "	10 p.c.	10 p.c.	28 p.c.	3 p.c.
5 p.c. " + vi.	25	1 "	8 p.c. (" 5-7 ")	40 p.c.	15	3 "	0 p.c.	0 p.c.	40 p.c.	0 p.c.
1 p.c. " + vi.	20	2 "	0 p.c. (" 6-8 ")	4 p.c.	28	1.5 "	0 p.c.	4 p.c.	2 p.c.	3 p.c.
40 p.c. " + vi.	38	1 "	7 p.c. (" 15 mins.)	44 p.c.	21	3 "	0 p.c.	0 p.c.	44 p.c.	0 p.c.
10 p.c. " + vi.	47 (m)	1 "	14 p.c. (" 1 1/2 hours)	70 p.c.	11	2 "	20 p.c.	40 p.c.	76 p.c.	20 p.c.
30 p.c. " + vi.	30	1 "	5 p.c. (" 1 ")	48 p.c.	20	2.5 "	5 p.c.	10 p.c.	48 p.c.	4 p.c.
20 p.c. " + vi.	52	1 "	8 p.c. (" 2 1/2 ")	52 p.c.	26	2 "	16 p.c.	20 p.c.	52 p.c.	10 p.c.
Control	20 flies in 4 days		...	0 p.c.						
"	28 " 6 "		...	7 p.c.						
"	35 " 9 "		...	0 p.c.						
"	2 " 5 "		...	0 p.c.						
Starved flies	30 flies in 3 days		2 p.c. (after 6-8 hours)	100 p.c.						
"	27 + 2 " 5 "		0 p.c. (" 24 ")	100 p.c.						
"	16 " 5 "		6 p.c. (" 24 ")	94 p.c.						

and this was with a 30 % formalin bait (*i. e.*, 25 c.c. of 30 % formalin in 75 c.c. of casein mixture), making 7.5 % of pure formalin (Table III.). Amongst substances which did not kill until the second day, excluding No. 5* of Table IV., ammonium nitrate (*i. e.*, 5 % pure NH_4NO_3) gave the highest percentage (53 %). Next came 40 % formalin (45 %), and then antimony oxychloride (37.5 %). For the percentages with the other substances, see Table IV.

Other experiments were also made to see what was the effect of first feeding a poison-bait to the flies in the cylinders, and then a clean bait to the survivors. Details of these experiments, giving percentages of deaths, etc., will be found in Table V.

The results seem to show that the flies died after a longer or shorter time from the effects of feeding upon the poisons, and not from starvation due to not feeding on the baits because they were distasteful, for in most cases flies were seen to feed. Also, in the experiments on starving flies, it was seen that these flies could live longer before succumbing than did the flies which had been given poison-baits; for in these the percentage of deaths during the first hours was very high—much higher, in fact, than amongst the starved flies for a corresponding length of time. Again, the percentage of deaths in those experiments where the poison-bait was left for more than one day was much lower than was found amongst the starved flies for a period of three days or more. It appears that when flies died from the effects of feeding upon those baits in which the poison was more concentrated they quickly absorbed sufficient to kill them, but that this took a longer time with weaker poisons, unless the bait was very attractive and they fed so greedily upon it as to imbibe a sufficient amount of the poison to kill them in a shorter time. This is apparently what happened with a 10 % formalin bait, which was very attractive, and to which very many of the flies came to feed at once and continued feeding for some time. On the other hand, if they fed less continuously a longer time elapsed before death took place. Probably the large percentage of deaths amongst the survivors with clean baits, as compared with the death-rate in the controls, was due to the poison previously absorbed in the first case.

Starved Flies.—From experiments on starving flies (Tables II. and V.) it seems that they show more power of resistance late in the year than in the autumn. For in the experiments made on starving flies in November and December they remained alive without food for 7–10 days, or even longer; while in those made in September and October all the flies were dead by the sixth day. The greater resistance shown by the winter flies than by the autumn ones is what would be expected if they have to pass the winter as imagines.

* This is not counted, although it had the highest death-rate, because no record was taken on the first day, and it is very probable that some of the flies died on that day.

GENERAL SUMMARY.

The general conclusions resulting from these experiments on baits and poisons for flies, show that:—

- (1) For Blow-flies, meaty substances of all kinds make the best baits, and of these the most attractive was blown liver, several days old. It was found that the digestive action of the maggots increased the attractiveness of the baits.
- (2) The most satisfactory House-fly baits consisted of mixtures of casein, banana, and some sweet substance (*i. e.* treacle, sugar, etc.) to which sufficient water, beer, or stout was added to make a paste.
- (3) Apparently Formalin remains the best poison for House-flies for indoor use, in spite of its somewhat uncertain action. The best results were obtained when 2.5 % to 7.5 % pure Formalin was used.

NOTE ON *EMPUSA MUSCÆ*.

It is perhaps worth noting that the house-flies in the "fly-room" became badly infected with the fungal disease *Empusa muscæ* in September and October, and died in great numbers, although they still continued to breed. It is interesting to note that however they became infected, the disease followed its usual course and subsided in November and December, when "wild" flies have normally disappeared.

Carbolic acid was evaporated two or three times a day at first, and occasionally up to the end of December.

NOTE ON THE PROPORTION OF THE SEXES IN HOUSE-FLIES
(*MUSCA DOMESTICA*).

(1) The proportion of male and female House-flies was found to be nearly equal in the various counts made on emerging flies. The results are given below:—

	♂.	♀.
(a) Pupæ taken from manure-heap which hatched out Aug. 7, 1915.	51	66
(b) Flies emerged from pupæ bred in greenhouse, Aug. 27, 1915 ..	52	35
(c) Ditto, Aug. 26-30, 1915	51	102
(d) Ditto, Aug. 27-28, 1915	57	39
(e) Ditto, 11 A.M. to 2 P.M., Aug. 28, 1915	60	53
(f) Ditto, at 2.45 P.M., August 28, 1915	121	67
(g) Ditto, at 3.30 P.M., Aug. 28, 1915	80	111
(h) Flies emerged from pupæ from breeding-saucers Feb. 11, 1916..	31	27
Total	503	500

(2) Counts were also made of Flies caught in balloons and
36*

other traps. In all cases but one, a much larger number of females was caught. This is probably to be accounted for by the fact that the substances used as baits served also for breeding-materials. The following results were obtained:—

		♂.	♀.
A. In the greenhouse.			
(a)	Flies caught in jar with wire-gauze funnel, baited with an eight days' old mixture of casein, water, and bread, 3-5 hours after Amyl acetate had been added, July 25, 1915	19	227
(b)	Flies caught in jar with wire gauze-funnel, baited with two days' old stout and sugar, Aug. 1, 1915	25	85
(c)	Flies caught on piece of banana, placed on shelf in sun. (Very many flies came to feed, and many eggs were laid.) As many as possible of the flies were caught	16	32
B. In the "fly-room."			
(a)	Flies caught in balloon trap, set for $\frac{1}{2}$ -1 hour over casein, brown sugar, banana, and water bait, Nov. 29, 1915	26	118
(b)	Ditto, Dec. 10, 1915	90	83
(c)	Ditto, Dec. 11, 1915	24	36
(d)	Ditto, Dec. 13, 1915	43	54
(f)	Ditto, for $\frac{1}{4}$ hour, Dec. 15, 1915	86	108
(g)	Ditto, for $1\frac{1}{2}$ hours, Feb. 9, 1916	13	22
(h)	Ditto, for 1 hour, Feb. 9, 1916	31	43
(i)	Ditto, for 24 hours, Feb. 10, 1916	28	52
Total		401	860

(3) Counts were also made of the flies which died naturally, which had been picked up in the "fly-room" in August and September. The proportion of males and females was approximately equal. The numbers are given below:—

		♂.	♀.
(a)	Dead flies picked up in fly-room on Aug. 28, 1915	122	99
(b)	Ditto, Aug. 20 to Sept. 2, 1915	132	143
Total		254	242

(4) Again, in the experiments where various poison-baits were fed to house-flies enclosed in cylinders (Table II.) only in 14 out of 69 cases was the percentage of deaths among the females higher than that of the males.

LIST OF ABBREVIATIONS.

Alc.	Alcohol (90 % unless otherwise stated).
Abs. Alc.	Absolute Alcohol.
Adren. HCl.	Adrenalin hydrochloride, .01 % solution.
Caff.	Caffeine.
Dimethan.	Dimethylaniline.
Ethyl. SCN.	Ethyl sulphocyanide.
F.	Formalin.
Meth. salic.	Methyl salicylate.
Nic.	Nicotine.
Potass. salic.	Potassium salicylate.
Pyrid.	Pyridine.

Salic. acid	..	Salicylic acid.
Sb. oxych.	..	Antimony oxychloride.
Turp. ....	..	Turpentine.
Zn. Sulp. Carbl.	..	Zinc sulphocarbolate.
dry ..	..	bait dry or getting dry.
eth. ....	..	house-flies used in experiments after they had recovered from being etherized.
<i>f</i> ..	..	few flies feeding on bait (<i>i. e.</i> about 3-6 flies).
<i>m</i> ....	..	many flies feeding on bait (<i>i. e.</i> most flies in cylinder).
mst. ....	..	bait moist, often with liquid coming out at edges.
(<i>h</i>) ..	..	flies helpless but alive.
<i>s</i> ...	..	some flies feeding on bait (<i>i. e.</i> about 8-10 flies).
×	..	flies came at once to feed on bait.
÷	..	flies did not come at once to feed.
*	..	flies came at once to bait, but did not stay.
(<i>p</i>) ..	..	pupæ (<i>i. e.</i> flies which had emerged from pupæ placed in cylinder).
(<i>p</i>*) ..	..	Flies emerged from pupæ (<i>p</i>), and which had been given no food for several hours before experimental bait fed to them.
(<i>p</i> ¹) ..	..	Flies newly emerged from pupæ (<i>p</i>).

The index numbers to reference number of experiments in Table II. indicate that the same control was used for all the experiments with the same index, *e. g.* (41)², (42)², etc.

KEY TO MIXTURES USED AS BAITS IN EXPERIMENTS IN TABLE II.

<i>Mixture i.</i> = Approx. 100 c.c. casein. + 100 c.c. brown sugar. + one banana. + water to mix into a paste	}	Mixed together at one time, and of which approx. 25 c.c. were used for each experiment, and to which Formalin was added.
<i>Mixture ii.</i> = Same as <i>Mixture i.</i> but of which 35 c.c. was used for the experiment, (5 only) and to which 2 c.c. of 4% Formalin was added.		
<i>Mixture iii.</i> = 15 c.c. casein. (15 only) + 15 c.c. brown sugar. + 40% Formalin.		
<i>Mixture iv.</i> = 15 c.c. casein. (16 only) + 15 c.c. brown sugar. + 10 c.c. water. + 5 c.c. 40% Formalin.		
<i>Mixture v.</i> = 25 c.c. casein. + 25 c.c. brown sugar. + 25 c.c. Formalin (percentage specified in each case).	}	Mixed separately for each experiment.
<i>Mixture vi.</i> = 25 c.c. casein. + 25 c.c. brown sugar. + 25 c.c. banana. + 25 c.c. liquid (percentage of Formalin, or other liquid, specified in each case).		
<i>Mixture vii.</i> = 25 c.c. casein. + 25 c.c. brown sugar. + 25 c.c. 24% Formalin in milk (<i>i. e.</i> milk (not water) added to make up to 24% F.).		
<i>Mixture viii.</i> = 25 c.c. casein. + 25 c.c. brown sugar. + 25 c.c. banana. + 25 c.c. water.	}	Mixed separately for each experiment. The various substances used were dissolved in 25 c.c. water, before it was added to mixtures. In Controls water only was used.
<i>Mixture ix.</i> = 25 c.c. casein + 25 c.c. brown sugar. + 25 c.c. banana. + 25 c.c. water.		
	Mixed separately for each experiment. Before the water was added to the mixture, the liquid (specified in each case) was added to the water.	

Mixture x. = 25 c.c. casein.
 (59 only) + 25 c.c. brown sugar. } 1 grm. benzoic acid dissolved in 4 c.c. of
 + 25 c.c. banana. } 90 % of alcohol was added to the 25 c.c.
 + 25 c.c. water. } water (when benzoic acid precipitated).
 The whole was mixed into the mixture.

Mixture xi. = 25 c.c. casein.
 + 25 c.c. brown sugar.
 + 25 c.c. banana.
 + 25 c.c. water, in which the various insoluble substances were mixed.

Mixture xii. = 25 c.c. casein.
 (92 only) + 25 c.c. sugar.
 + 25 c.c. banana.
 + 5 c.c. pyrethrum powder extract (alc.).

Mixture xiii. = 12.5 c.c. casein.
 (121 only) + 12.5 c.c. brown sugar.
 + 12.5 c.c. banana.
 + 12.5 c.c. of ($\frac{1}{20}$ exol. mark iii. + 1 % mustard oil + 0.25 ethyl sulphocyanide).

Mixture xiv. = 12.5 c.c. casein.
 (122 only) + 12.5 c.c. brown sugar.
 + 12.5 c.c. banana.
 + 12.5 c.c. 1:20 ethyl thiocyanide + cinnamic + exol mark iii.

Mixture xv. = Brown bread soaked in (1 c.c. exol mark iii. + 1 grm. sugar + 18 c.c. (128 only) water).

Mixture xvi. = Paper sprayed with (1 c.c. exol mark iii. + 1 grm. sugar + 18 c.c. (129 only) water) and allowed to dry before fed to flies in cylinder.

Mixture xvii. = Brown bread soaked in 3 drops ethyl sulphocyanide + 25 c.c. water.
 (130 only)

Iodine = 5 c.c. of (1 grm. iodine dissolved in 5 c.c. of 90 % alcohol).
 (141 only)

(NB.—All solutions aqueous unless otherwise stated.)

21. Note on the Sternum of a large Carinate Bird from the (?) Eocene of Southern Nigeria. By C. W. ANDREWS, D.Sc., F.R.S., F.Z.S. (British Museum Nat. Hist.) *.

[Received and Read May 23, 1916.]

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The British Museum has recently received from Nigeria two small collections of vertebrate remains of great interest. The first, presented last year by Sir F. Lugard, G.C.M.G., was obtained in a cutting on the Port Harcourt railway in the Ombialla District, Southern Nigeria: in this the most important specimens are portions of the lower jaw of a primitive Zeuglodont, vertebrae of a crocodile, and numerous remains of fishes, including *Cœlorhynchus* and *Galeocерdo latidens*; a large number of Mollusca were also included. The second collection was sent by J. Eaglesome, Esq., C.M.G., and is from the same locality as the last; it includes further remains of the Zeuglodont, part of the sternum of a gigantic carinate bird, parts of the carapace of a leathery turtle, probably near *Psephophorus*, and some portions of skulls of Siluroid fishes. It is to the avian sternum alone that the present paper refers.

The age of the beds in which these fossils occur has not yet been definitely settled, but from the character of the vertebrate remains it was probably Eocene, and most likely the earlier part of that period. For instance, the presence of *Cœlorhynchus* ‡ and *Galeocерdo latidens* points to the Eocene age of the deposits, while the primitive creodont-like condition of the teeth of the Zeuglodont favours their reference to the earlier part of the period. The Mollusca have not yet been examined in detail, but Mr. R. B. Newton seems inclined to consider that they may indicate a somewhat later horizon.

The subject of the present note is the anterior part of the sternum; it was in two pieces, and the visceral surface was to a great extent concealed by a matrix of extreme hardness, which was difficult to remove. The anterior part of the keel and the body of the bone nearly to the level of the posterior ends of the

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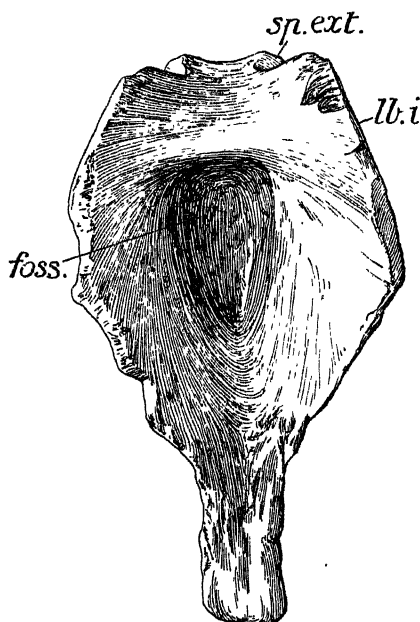
† [The complete account of the new genus and species described in this communication appears here; but since the name and a preliminary diagnosis were published in the 'Abstract,' No. 158, 1916, the genus and species are distinguished by the names being underlined.—EDITOR.]

‡ A. S. Woodward, Abstract Proc. Geol. Soc. No. 989 (1916), p. 51.

coracoid grooves are preserved, but behind this only a portion of the middle of the body is present, all the posterior expansion being broken away.

The middle portion of the anterior part of the visceral surface is hollowed out into a deep fossa (*foss.*) about 2.6 cm. wide, deepening and slightly narrowing from before backwards for about 4 cm., and then dying away posteriorly. This depression was probably connected with pneumatic foramina, opening into the base of the keel. In front of the fossa above described is a broad transverse

Text-figure 1.



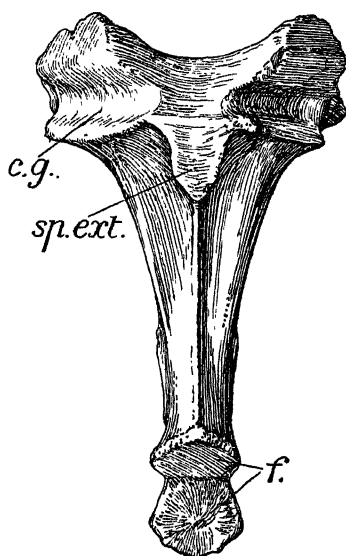
Sternum of *Gigantornis eaglesomei*, from above. $\frac{1}{2}$ natural size.

foss., fossa in visceral surface; *lb.i.*, labrum internum of coracoid groove;
sp.ext., spina externa.

ridge convex from before backwards and extending between the anterior ends of the prominences overhanging the coracoidal grooves; anteriorly this ridge is smoothly concave from side to side, there being no trace of a *spina interna*. The anterior ends of the coracoid grooves are separated by an interval of about 1.8 cm.; the grooves themselves are straight and deep and are overhung by a parallel convex surface (*labrum internum*, *lb.i.*). They make an angle of about 55° with one another and are about 7.7 cm. long, but their ventral lip begins to die away posteriorly

about 1 cm. from their hinder extremity; it is not possible to tell whether there was an accessory posterior coracoid groove as in the Petrels generally, that region of the sternum having been lost. Beneath and between the anterior ends of the coracoid grooves is a strongly developed *spina externa* (*sp. ext.*), the anterior escutcheon-shaped face of which was nearly vertical with regard to the long axis of the sternum; from its ventral angle a strong intermuscular ridge is continued down the anterior border of the carina, dividing it into two lateral surfaces and terminating at the upper border of the facet for articulation with the furculum. The carina itself is

Text-figure 2.

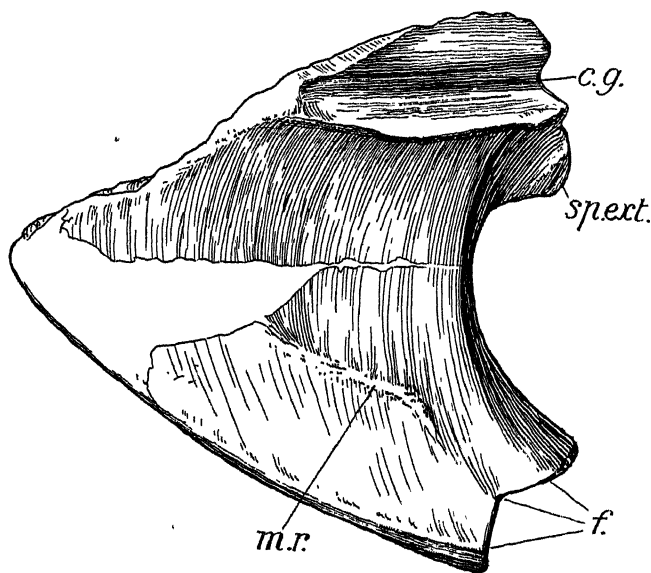
Sternum of *Gigantornis eaglesomei*, from front. $\frac{1}{2}$ natural size.

c.g., coracoid groove; *f.*, facet for furcula; *sp. ext.*, spina externa.

deep and is prolonged forwards and downwards; posteriorly it seems to have narrowed with exceptional rapidity, so that it may have been confined to the anterior portion of the body of the sternum, but, owing to the incompleteness of the specimen, its precise form cannot be determined. The anterior border is broad above and concave from side to side on either side of the median ridge above referred to; externally it is separated by sharp angles from the lateral surfaces. Lower down the anterior border narrows and becomes convex from side to side. The anterior angle of the carina, which projected rather strongly forwards, is truncated by an extraordinarily large surface for union with the

lower end of the furculum. This surface looks nearly directly forwards and is concave from above downwards; seen from the front (text-fig. 2) it is somewhat constricted in the middle, the constriction apparently separating distinct upper and lower articular facets, between which there is a roughened area; the upper facet is the more clearly defined, and the whole structure indicates the existence of an extremely strong union between the sternum and the lower end of a very large furcula. The ventral border of the keel is gently convex from before backwards, and also from side to side, the middle line being marked by a longitudinal intermuscular ridge. It is about 2.6 cm. wide in front, but narrows rapidly to about 1.5 cm.; further back the width becomes still further reduced.

Text-figure 3.

Sternum of *Gigantornis eaglesomei*, from side. $\frac{1}{2}$ natural size.

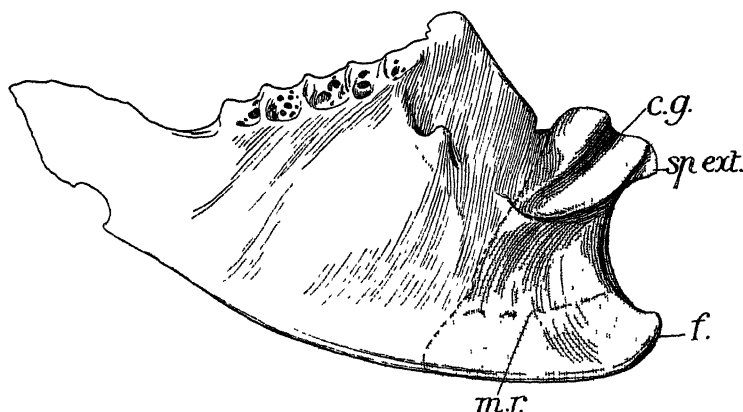
c.g., coracoid groove; f., facet for furcula; m.r., intermuscular ridge;
sp.ext., spina externa.

The lateral surface of the keel is slightly concave both from above downwards and before backwards; the concavity is most marked beneath the hinder end of the coracoid grooves, where the bone is very thin. The intermuscular ridge between the surfaces for the attachment of the *pectoralis major* and *pectoralis secundus* is extremely strongly developed. It commences about 2 cm. behind the middle of the clavicular facet, and for a short distance

runs upwards and backwards, then turns backwards; posteriorly it seems to have curved up in the direction of the posterior end of the coracoid groove; beneath the strongly developed ridge itself and connected with it are several roughened surfaces. The smooth sides of the keel are marked by numerous fine vascular impressions.

The chief peculiarities of this sternum, apart from its large size, are (1) the remarkable strength of its articulations with the coracoids and furcula, indicating the possession of an extremely powerful support for the wings; (2) the presence of a deep fossa on the visceral surface; (3) the very strongly marked intermuscular ridges. These characters seem to show that this bird was a powerful fier, and perhaps also a good swimmer and diver. It is undoubtedly generically distinct from any known species, and I have proposed for it the generic name *Gigantornis*, the specific name being *G. eaglesomei*, in honour of the discoverer [Abstract P. Z. S. 1916, p. 30 (May 30th)].

Text-figure 4.



Sternum of *Diomedea exulans*, from side. $\frac{1}{2}$ natural size.

Lettering as in text-fig. 3.

The stippled area indicates the portion preserved in the fossil.

This sternum has been compared with those of many recent birds, and it seems to resemble in some respects those of certain of the Tubinares and Steganopodes. The anterior aspect is much like that of the sternum of *Diomedea* (text-fig. 4), the form of the spina externa especially being almost the same; the disposition of the intermuscular ridges on the carina is also very similar. On the other hand, in *Diomedea* the coracoid grooves are more oblique, and their anterior ends are separated by a shorter interval; moreover, there is no deep fossa on the dorsal surface,

and, although the anterior angle of the keel widens out and was in contact with the furcula, there was no definite articulation between the two. In other members of the group, however, some of these characters are present. Thus, in *Procellaria* the dorsal fossa is present, and in the Diving Petrels (*Pelecanoides*) the furcula has a definite articulation with the anterior end of the sternum, and it seems possible that this articulation may in some way be connected with the diving-habit, since it is well developed in *Sula* and *Phalacrocorax*, both notable divers; on the other hand, *Fregata*, in which the furcula is actually fused with the sternum, seems never to dive. Comparison of the fossil with the sterna of *Sula* and *Phalacrocorax* in other respects, shows that in the depth and shortness of the keel and in the form and position of the coracoid grooves they are somewhat similar. On the other hand, the keel projects much more forwards, the spina externa is thin and compressed, there is no dorsal fossa, and the position of the intermuscular ridges on the keel is different.

Comparison with the sterna of other groups of birds has led to no satisfactory results. In the case of some of the Storks (e. g. *Argala*) the furcula has an extensive union with the anterior angle of the keel, but in other respects the form of the sternum differs from the fossil. The sterna of the Penguins and Auks also differ widely, the keel being very long and there being no union with the furcula. On the whole, we may conclude that *Gigantornis* was most nearly related to the Tubinares and Steganopodes, perhaps approaching the former more nearly, and it may, indeed, be the representative of an extinct group more or less intermediate between these two.

Further collections from the same locality are greatly to be desired, since nearly all the few specimens hitherto obtained represent forms new to science and of the highest interest.

Some dimensions (in millimetres) of the fossil are:—

Length of the portion of body preserved	136
Greatest depth from anterior upper border of body to antero-inferior angle of keel	140
Distance from anterior angle of coracoid groove to antero-inferior angle of keel	127
Length of coracoid groove..... (app.)	77
Distance between anterior ends of coracoid grooves	18
Depth of surface for furcula..... (app.)	45
Greatest width of surface for furcula.....	26
Thickness of lower border of keel at level of hinder end of coracoid grooves	12

Text-fig. 4 represents the sternum of a large Wandering Albatross (*Diomedea exulans*), which in the flesh measured 10 ft. 8 in. from tip to tip of the wings; the fossil sternum, so far as measurements are possible, seems to have been about twice as large.

22. On a Mammalian Mandible (*Cimolestes cutleri*) from an Upper Cretaceous Formation in Alberta, Canada. By ARTHUR SMITH WOODWARD, LL.D., F.R.S., V.P.Z.S.

[Received and Read May 23, 1916.]

(Text-figure 1.)

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Small mammals with a dentition closely similar to that of the existing opossums have long been known by fragments from the Upper Cretaceous freshwater deposits of North America. Complete jaws, however, are still needed to correlate the isolated teeth which form the majority of the fossils hitherto discovered. An imperfect right mandibular ramus lately obtained for the British Museum by Mr. William E. Cutler is thus of special interest; and its value is increased by the fact that it was discovered in Alberta, Canada, in a somewhat older deposit than the Laramie Formation of Wyoming, U.S.A., in which the previous specimens were found.

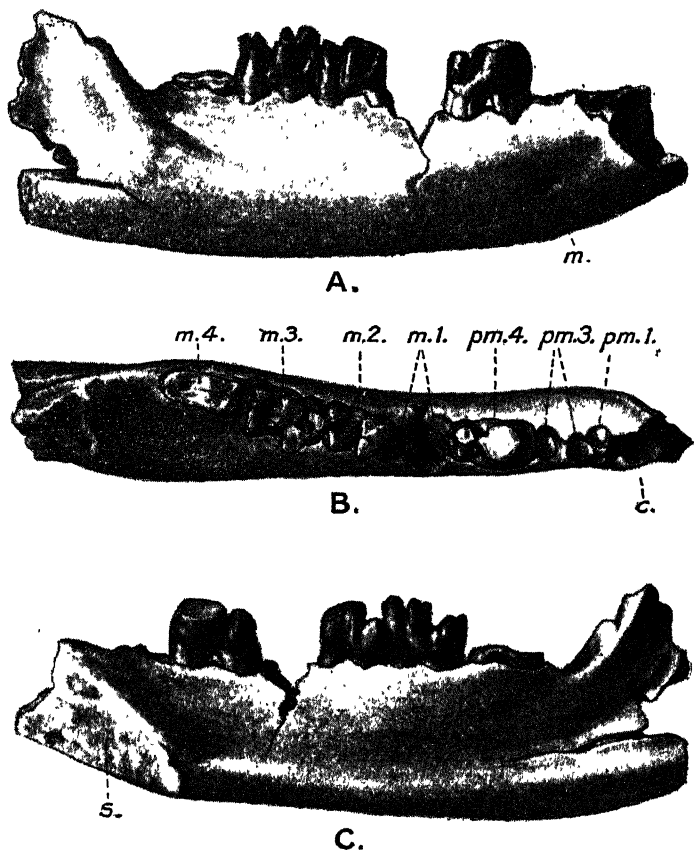
The new mandibular ramus lacks most of the hinder ascending portion and the extremity of the mandibular symphysis, but is otherwise well preserved, with two of the molars, one premolar, the broken roots of the other molars and premolars, and the socket for the large canine tooth. It is shown of twice the natural size, from the outer, upper, and inner aspects in the accompanying text-figure (p. 526). The mandibular symphysis is much elongated, the facette (*s.*) extending as far backwards as the anterior root of the fourth premolar. The large mental foramen (*m.*) on the outer face of the ramus is also situated beneath and just in front of the anterior root of the same premolar.

The four molars and three premolars behind the canine are arranged in close series, and the teeth preserved are considerably worn, showing that the jaw belongs to a fully adult individual. The smooth enamelled crown of these teeth slightly overhangs the root, but there is no cingulum on the outer or inner face. A cingulum is only observable on the anterior and posterior faces of the two molars, where it slopes downwards and outwards. The fourth molar (*m.* 4), which must have been at least as large as the

* [The complete account of the new species described in this communication appears here, but since the name and a preliminary diagnosis were published in the 'Abstract,' No. 158, 1916, the species is distinguished by the name being underlined.—EDITOR.]

third, is represented only by its double-rooted base. The third and second molars closely resemble those of the opossums, each consisting of a much-raised tricuspoid anterior portion (trigonid)

Text-figure 1.



Cimolestes cutleri; imperfect right mandibular ramus, outer (A), upper (B), and inner (C) aspects, twice nat. size.—Upper Cretaceous (Belly River Series): Sand Creek, Red Deer River, Alberta, Canada.

m., mental foramen; *s.*, symphyseal facette; *m.* 1-4, molars; *pm.* 1, 3, 4, premolars; *c.*, socket for canine.

with a less raised but extended posterior heel (talonid). The third molar (*m.* 3) is implanted by two very stout roots, of which the posterior is the larger. The relatively large outer cusp

(protoconid) of its trigonid is much more worn than the two inner cusps, of which the anterior (paraconid) is the larger and well separated from the posterior (metaconid) by a deep cleft. Its posterior heel (talonid) is bordered by a much raised rim, which is sharply separated by a groove from the trigonid, and bears one large outer cusp (hypoconid), a smaller inner cusp (entoconid), and a still smaller posterior cusp (hypoconulid), all considerably worn. In the second molar (*m. 2*) the three cusps of the trigonid are about equally worn, and the raised rim of the talonid closely resembles that of the third molar already described, but appears to be more worn. The first molar, represented only by fragments of the roots, is comparatively small. The fourth premolar (*pm. 4*) is very large and inserted by two divergent roots, of which the posterior is the stouter, and both are marked by slight vertical flutings. Its crown consists of a tumid antero-posteriorly elongated cone, with a small, well separated pillar-like cusp behind. The apices of the cone and cusp are truncated by wear, and the large worn surface of the crown is extended by a second small surface of wear antero-internally. The enamel of its outer face exhibits faint traces of vertical wrinkling. The small third premolar is represented only by its two roots (*pm. 3*), and the diminutive foremost premolar, generally regarded in opossums as the first of the normal series, is shown by its simple root (*pm. 1*) to have been displaced inwards. The socket for the procumbent canine (*c.*) is relatively large; and the shape of the broken end of the symphysis suggests that the incisors were very small.

The following are some of the principal measurements, in millimetres:—

Total length of dental series behind canine ...	30
M. 4, maximum length (about)	6
M. 3, " length	5.5
" breadth.....	3.5
M. 2, " length	4.5
" breadth.....	3.5
M. 1, " length (about)	4
Pm. 4, " length	5.5
" breadth.....	3.5
Pm. 3, " length (about)	4.5

The dentition thus described is closely similar to that of the existing *Didelphys*, but differs in the shape of the large hinder premolar, and doubtless represents a distinct genus. Molar teeth of the same pattern from the Cretaceous Laramie Formation of Wyoming, U.S.A., were named *Cimolestes* by Marsh*, who assigned them to an imperfect jaw in which the sockets indicated

* O. C. Marsh, "Discovery of Cretaceous Mammalia," Amer. Journ. Sci. [3] vol. xxviii. (1889) p. 89.

a close series of seven teeth behind the canine without any diastema*. The new specimen may therefore be provisionally referred to *Cimolestes*, and as it differs from the type-species (*C. incisus*) by its larger size, and both from this and a second Laramie form (*C. curtus*) by the relatively less elevation of the trigon in the molars, it doubtless represents a new species, which may be appropriately named *C. cutleri* after its discoverer [Abstract P. Z. S. 1916, p. 30 (May 30)]. The large fourth premolar, if it had been found separately, would have been described as *Stagodon* in the nomenclature of Marsh; but it seems to have characterised more than one genus of Cretaceous Marsupials†.

* O. C. Marsh, "Discovery of Cretaceous Mammalia.—Part III.," *loc. cit.* vol. xliii. (1892) p. 258, pl. ix. figs. 5, 6.

† Compare *Thlæodon padanicus*, E. D. Cope, Amer. Naturalist, vol. xxvi. (1892) pp. 758-762, pl. xxii.

23. A List of the Carabidæ (Coleoptera) collected in Chopersk District, Province of the Don Cossacks, South Russia. By V. LUTSHNIK, Kiev, Russia*.

[Received April 25, 1916: Read May 23, 1916.]

The present paper contains a list of the Carabidæ collected by Mr. A. I. Ilijinski and his brother, Mr. P. I. Ilijinski, who was killed on the battlefield, in the Chopersk district of the province of the Don Cossacks. The species catalogued were collected in the neighbourhood of the stations Filonovskaja and Urjupinskaja †.

1. CICINDELA GERMANICA L.—F. 7. viii. 1911; 19. vi. 1912; U. 20. vi. 1912.

Very common. Except f. typ., also ab. *fusca* D.-Torre, ab. *protos* D.-Torre, ab. *deuteros* D.-Torre and ab. *obscura* F.

2. CICINDELA MARITIMA SAHLBERGI Fisch.-W.—F. 17. vii. 1912.

Sandy places, not common.

3. CARABUS (s. str.) GRANULATUS L.—U. 14. vi. 1914.

One example.

4. CALOSOMA (s. str.) SYCOPHANTA L.—F. 28. v. 1909.

5. CALOSOMA (CHARMOSTA) DENTICOLLE Gebl.—F. 4. vii. 1912.

6. EPACTIUS LIMBATUS F.—F.

One specimen.

7. CLIVINA COLLARIS Herbst.—F. 20–25. vii. 1913.

8. BEMBIDION (NOTAPHUS) SEMIPUNCTATUM Donovan.—F. 12. vii. 1910.

9. BEMBIDION (PERYPHUS) ANDREÆ F.—F. 25. vii. 1911.

10. BEMBIDION (PERYPHUS) USTULATUM L.—F. 28. v.–12. vii. 1913.

11. BEMBIDION (s. str.) ILLIGERI Neto.—F. 23–26. vi. 1912.

12. BEMBIDION (PHILOCHTHUS) BIGUTTATUM F.—F. 15. vii. 1910 ‡.

13. CHLÆNIUS (CHLÆNITES) SPOLIATUS LONGIPENNIS Motsch.—F. 12. vii. 1910.

14. CHLÆNIUS (CHLÆNIELLUS) NITIDULUS Schr.—F. 24. v. 1910.

15. DOLICHUS HALENSIS Schall.—28. vi.–12. vii. 1913.

* Communicated by the SECRETARY.

† Abbreviated as: F.=Filonovskaja; U.=Urjupinskaja.

‡ Mr. Ph. Zaitzev has recorded *Bembidion argenteolum* Ahr. v. *chalybæum* Strm. from Urjupinskaja (Revue Russe d'Entomol. ix. 1909, no. 4, p. 491).

16. AGONUM (s. str.) IMPRESSUM Panz.—F. 12. vii. 1910.
17. AGONUM (s. str.) SEXPUNCTATUM L.—F. vii. 1911.
18. AGONUM (s. str.) GRACILIPES Duft.—F. 15. vii. 1910; U. 20. vi. 1912.
19. AGONUM (IDIOCHROMA) DORSALE Bruenn.—F. 23. vi.-5. vii. 1912.
Common.
20. PLATYSMA (SOGINES) PUNCTULATUM Schall.—F. 24. vii. 1911; U. 16. vi. 1914.
21. PLATYSMA (MACROPECILUS) SERICEUM Fisch.-W.—F. 6. vii. 1912.
22. PLATYSMA (s. str.) NIGRUM Schall.—F. 3. vii. 1911.
23. PLATYSMA (MELANIUS) ANTHRACINUM Ill.—F. 23-26. vi. 1912.
24. AMARA (TRIENA) PLEBEJA Gyll.—F. 2. vii. 1911.
25. AMARA (s. str.) SIMILATA Gyll.—F. 2. vii. 1911; U. 12. vi. 1913.
26. AMARA (s. str.) AENEAE Deg.—F. 23-26. vi. 1912.
27. AMARA (CELIA) INGENUA Duft.—F. 18. vii. 1910, 28. vi.-12. vii. 1913.
28. AMARA (BRADYTUS) APRICARIA Payk.—F. 12. vii. 1910, 30. vi. 1911, 23. vi.-4. vii. 1912, 28. vi.-12. vii. 1913; U. 16. vi. 1913.
Very common.
29. AMARA (BRADYTUS) FULVA Deg.—F. 3. vii. 1912.
30. AMARA (BRADYTUS) CONSULARIS Duft.—F. 4. vii. 1912.
31. HARPALUS (OPIHONUS) SABULICOLA Panz.—U. 20. vi. 1912.
32. HARPALUS (OPIHONUS) AZUREUS F.—F. vi. 1912.
33. HARPALUS (PSEUDOPHONUS) PUBESCENS Muell.—F. 23-26. vi. 1912, 23. vi.-2. vii. 1913; U. 20. vi. 1912.
34. HARPALUS (PARDILEUS) CALCEATUS Duft.—F. 12-15. vii. 1910, 30. vi.-22. vii. 1911, 2-6 vii. 1912, 20. vi.-12. vii. 1913.
Very common.
35. HARPALUS (s. str.) AENEUS F.—F. 30. vii. 1910, 5-26. vii. 1912, 20. vi.-12. vii. 1913; U. 20. vi. 1912, 17. v. 1913.
Common.
36. HARPALUS (s. str.) PSITTACEUS Geoff.—F. vi. 1912.
One example.

37. *HARPALUS* (s. str.) *SMARAGDINUS* Duft.—F. 7–31. vii. 1910, 30. vi. 1911, 2–31. vii. 1912, 20. vi. 1913; U. 14–17. v. 1913.
38. *HARPALUS* (*ACARDYSTUS*) *RUFUS* Bruegg.—F. 2. vii. 1912.
39. *HARPALUS* (*AMBLYSTUS*) *LATUS* L.—F. 23–26. vi. 1912.
40. *HARPALUS* (*HARPALOBIOUS*) *FROELICHI* Strm.—F. 12–18. vii. 1910.
Two specimens.
41. *HARPALUS* (*HARPALOBIOUS*) *HIRTIPES* Panz.—F. 30. vi. 1911, 4–8. vii. 1912, 28. vi.–12. vii. 1913; U. 17. v. 1913.
Common.
42. *HARPALUS* (*PHEUGINUS*) *SERVUS* Duft.—F. 4. vii. 1912.
43. *HARPALUS* (*PHEUGINUS*) *SEERIPES* Quens.—F. 27. vi. 1911.
44. *HARPALUS* (*ACTEPHILUS*) *PICIPENNIS* Duft.—F. 20. vi. 1913.
45. *HARPALUS* (*MICRODERES*) *BRACHYPUS* Stev.—F. 20–25. vi. 1913.
46. *DIACHROMUS* *GERMANUS* L.—F. 15. vi. 1912.
One specimen.
47. *ANISODACTYLUS* (*HEXATRICHUS*) *PÆCILOIDES PSEUDOÆNEUS* Dej.
F. 27. vi. 1911.
48. *CORSYRA* *FUSULA* Fisch.-W.—F. 20–25. vi. 1913.
49. *CYMINDIS* *PICTA* Pall.—F. 10. vii. 1912.
50. *BRACHINUS* *INCERTUS* Brull.—F. 20. vi. 1913.
One specimen.
51. *BRACHINUS* *PSOPHIA* Dej.—F. vi.–vii. 1913.

24. A new Species of the Genus *Platysma* (Bon.) Tschitscherin, from China. By V. LUTSHNIK, Kiev, Russia*.

[Received April 25, 1916: Read May 23, 1916.]

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PLATYSMA MANDZHURICUM, sp. n.

Black, shining; legs and mouth-parts pitch-black.

Head large, smooth; front with a longitudinal impression on each side; eyes convex.

Prothorax subquadrate, narrowed behind, sides hardly rounded, not sinuate before base; the basal angles rounded off; anterior margin slightly emarginate; base subtruncate; the median line impressed, ending behind in a punctiform impression; a single deep and very wide, lightly punctate, impression on each side near the basal angles.

Elytra a little wider than prothorax, convex, slightly rounded on sides, truncate at base with the shoulders rounded; apical curve subsinuate on each side; striae strongly impressed, finely punctate; interstices subconvex, third with three punctures.

Under surface impunctate; apical segment (♂) deeply foveolate towards middle and with one setigerous puncture on each side of the anus.

Metasternal episterna slightly elongate.

Length 11.5 mm.

Hab. China: Manchuria (Chandaohedzy, 5. vii. 1914, A. Alexandrov).

One male specimen in my collection.

I regard this species as belonging to the subgenus *STEROPINUS*, subgen. nov., which, from its position, seems to be between the subgenera *Steropus* Steph. and *Eosteropus* Tschitsch. The form of the prothorax separates it from *Eosteropus* Tschitsch. and approximates to *Steropus* Steph. From the last subgenus, *Steropinus* Lutshn. differs by its elongate episterna and foveolate anal segment of the abdomen.

* Communicated by the SECRETARY.

25. Notes on Species of the Genus *Platysma* (Coleoptera)
from Australia. By V. LUTSHNIK, Kiev, Russia*.

[Received April 25, 1916: Read May 23, 1916.]

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I.

In one of my papers I have had occasion to indicate that the punctuation of the mesosternal and metasternal episterna in species of the subgenus *Sarticus* Motsch. (1864) is not important for their definition †.

I have now a sufficiently large number of specimens of this subgenus from Victoria to confirm the correctness of my remarks.

I have one example of *Platysma* (*Sarticus*) *habitans* Sloane (1889), from the Ballarat District, which has fully impunctate episterna, but in other features entirely conforms to the original description of this species ‡.

I have also one specimen of *Platysma* (*Sarticus*) *obesulum* Chaud. (1865) from the same locality, which has one punctate and one impunctate metasternal episterna. As is known, *Platysma* (*Sarticus*) *rockhamptoniense* Casteln. (1865) is distinguished from *Pl. (S.) obesulum* Chaud. only by its punctate episterna §. This distinction is not constant, and for that reason I consider *Pl. (S.) rockhamptoniense* Casteln. to be a synonym of the last species ||.

II.

In his "Review of the genus *Sarticus*," Mr. Th. G. Sloane ¶ erroneously writes regarding the subgenus *Sarticus* Motsch., "the basal segment of the abdomen is always punctate." This is not quite correct, because one of the species of this group, namely, *Platysma* (*Sarticus*) *saphyreomarginatum* Casteln. (1865), has the abdomen completely impunctate. In the original description of *Feronia cyaneocincta* Chaud. (1865) [= *Pl. saphyreomarginatum*], Chaudoir writes of this species "corpus totum læve" **.

My examples of *Pl. saphyreomarginatum* Casteln., from Victoria and Queensland, have the abdomen completely impunctate.

* Communicated by the SECRETARY.

† Lutshnik, V., "Sur quelques Platysmatini de la faune Australienne," *Revue Russe d'Entomol.* xiv. 1914, no. 4, p. 421.

‡ Sloane, Th., "Studies in Australian Entomology, no. I.," *Proc. Linn. Soc. New South Wales*, 1889, p. 508.

§ Sloane, Th., *op. cit.* p. 508.

|| Chaudoir, "Supplément à l'essai sur les Féronies de l'Australie," *Ann. Mus. Civ. Stor. Natur. di Genova*, vi. 1874, p. 595.

¶ Sloane, Th., *op. cit.* p. 502.

** Chaudoir, "Essai sur les Féronies de l'Australie et de la Nouvelle-Zélande," *Bull. Soc. Impér. Natur. de Moscou*, 1865, no. 3, p. 98.

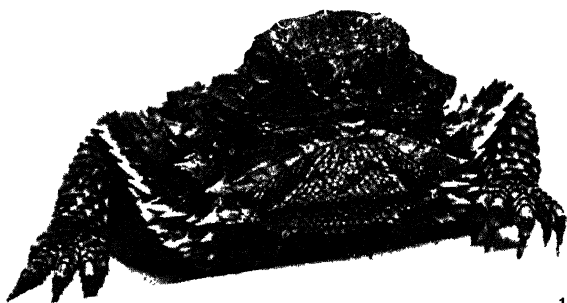
III.

The subgenus *Coronocanthus* Macl. (1877) is perfectly valid, but very near to *Sarticus* Motsch., as I have already indicated *. For *Platysma* (*Coronocanthus*) *sulcatum* Macl. (1877) = *Pl. quadrisulcatum* Chaud. (1878), it is necessary to conserve Chaudoir's name, because the name "*sulcatum*" has been already occupied in the genus *Platysma* (Bon.) Tschitsch †.

I have two examples (♂ and ♀) of this remarkable species from the Northern Territory.

* Lutshnik, V., *op. cit.*

† Gay, Hist. Chil. (Spanish edition), iv. 1849, p. 223 (*Feronomorpha sulcata*).



1



2.



3.

F. W. Bond, photo.

Bale & Danielsson, Ltd

PHRYNOSOMA BREVICORNIS.

26. On a new Lizard of the Genus *Phrynosoma*, recently living in the Society's Gardens. By E. G. BOULENGER, F.Z.S., Curator of Reptiles.

[Received May 12, 1916: Read May 23, 1916.]

(Plate I.)

Among a small collection of reptiles from Texas given to Dr. H. G. F. Spurrell by Prof. J. S. Huxley for presentation to the Society, I found a lizard of the genus *Phrynosoma*, which is evidently new, and for which I propose the name of *Phrynosoma brevicornis*. Superficially the lizard resembles *P. douglassii*, the head-spines being extremely short, but it differs in the nostrils being pierced within the canthi rostralis and in the pectoral and ventral scales being strongly keeled. From *P. taurus*, to which it is in some respects closely related, it differs in the much shorter head-spines, in the gular scales being smooth, and in the longer tail.

PHRYNOSOMA BREVICORNIS, sp. n. (Pl. I.)

Head broader than long, with the spines very small. Posterior outline of the head forming a slight concave curve. Nostril pierced within the canthus rostralis. Tympanum naked. Head-spines obliquely turned upwards: they number three temporal, two very small occipital, and a minute postorbital. The temporal head-spines largest, slightly larger than the largest spinose scales on the body. Lower labials terminating in a series of pointed scales. Gular scales equal, smooth. Gular fold strong. A dermal thickening bearing a few erect spines on each side between the gular fold and the tympanum. Back and limbs with scattered, erect, large, keeled, spinose scales. A regular lateral series of spines. Pectoral and ventral scales strongly keeled. Eleven femoral pores on each side, the series not joining medially. Tail about two and a quarter times as long as head. Yellowish brown above, pale yellow on the sides; lower surfaces yellowish white, uniform.

Total length 107 mm.

EXPLANATION OF THE PLATE.

Phrynosoma brevicornis.

- Fig. 1. Front view.
2. Side view.
3. Upper view.

EXHIBITIONS AND NOTICES.

May 23rd, 1916.

Dr. HENRY WOODWARD, F.R.S., Vice-President,
in the Chair.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited living specimens of the African Lungfish (*Protopterus annectens*), presented to the Society by Capt. C. W. Woodward.

The Rev. H. N. HUTCHINSON, M.A., F.Z.S., exhibited the plaster cast of a model, four feet long, which he had constructed, of the Dinosaur, *Diplodocus carnegiei*.

The object in making the model was to express in a solid form his views on the reconstruction and articulation of the skeleton of *Diplodocus*, with special reference to the plaster-cast of a reconstructed skeleton now in the British Museum (Nat. Hist.), and presented by Mr. Andrew Carnegie in 1905.

The late Dr. J. B. Hatcher, Dr. W. J. Holland, and others who have published papers on *Diplodocus* appear to be so anxious to make this extinct reptile appear very tall and impressive, that they have been so bold as to place the limbs in an upright position, as if the creature were an elephant. On the other hand, many naturalists, recognising the Sauropoda to be related to the Crocodilia, are persuaded that the limbs should be placed at an angle to the body somewhat as in the Lacertilia, a view which the speaker has expressed on the above model. He has tried to show that the articulations of the femur and the humerus are mechanically impossible. The broad spatulate end of the latter he thinks should not be put at right angles to the plane of the scapula and glenoid cavity, but must be turned round 90 degrees so as to come properly into line with the large surfaces of the scapula and coracoid.

A rare Fish.

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited a specimen of a rare fish, *Centrolophus britannicus* Günth. This species was described from a fish about 500 mm. long, which was washed ashore near Polperro in February 1859 (Günth. Cat. Fish. ii. p. 402, 1860). No other specimen was recorded until one of nearly the same size as the type was taken near Coruña in December 1904 (Cligny, Ann. Stat. Aquic. Boulogne, n. s. i. 1905, p. 75). A third example, of the same size as the others, was taken from the water in a dying condition, after a storm, at Capbreton, in March 1908 (Pellegrin, Bull. Soc. Zool. xxxvii. 1912, p. 20). The fish exhibited was the fourth known example of this species. It was landed in South Wales from the trawler

'Caswell,' and was sent by Mr. H. E. Rees to Mr. James V. Pryor at Cambridge; not recognizing the species, Mr. Pryor showed it to Professor Stanley Gardiner, and on his advice sent it to Mr. Regan.

Mr. Rees had kindly given the following information:—"The fish was caught by the steam trawler 'Caswell' on Sunday, May 7th, at 3 P.M. The vessel was fishing 95 miles S.S.E. of the Bull Rock, Ireland, in 300 fathoms of water. The fish was caught in the trawl on the sea-bottom and was alive when it was brought in on deck."

The fish is nearly 400 mm. long; it has 53 dorsal and 31 anal rays. The principal differences between *C. britannicus* and the more abundant *C. pompilus* appear to be as follows:—

C. britannicus.—D. 46–53. A. 28–33. About 240 scales in a longitudinal series above lateral line, which has a curve in the anterior $\frac{1}{3}$ of its length. Length of head $5\frac{1}{2}$ to 6 in length of fish.

C. pompilus.—D. 37–41. A. 23–25. 185 to 205 scales in a longitudinal series above lateral line, which has a long curve, becoming straight above origin of anal fin. Length of head 4 to 5 in length of fish.

Mr. Regan also exhibited a Silver Ling (*Molva elongata*), nearly 600 mm. long, taken from the stomach of a very large Sun-fish (*Mola mola*) that had been caught in a trawl, landed at Milford, and sent to Mr. W. Howlett of Billingsgate Market, who presented it to the Natural History Museum. The Sun-fish appears generally to swim near the surface and to eat small invertebrates, larval fishes, etc. It is interesting to note that it may descend to considerable depths (*M. elongata* is usually found at 100 to 300 fathoms) and that it may capture fairly large and active fish.

Albinism in American Animals.

Dr. R. W. SHUFELDT, C.M.Z.S., communicated the following notes on cases of albinism seen in American animals:—

"During the past half century I have noted and examined a great many instances of albinism in various parts of the United States, and as this condition is of interest from several points of view, I am presenting here a few notes I have made upon the subject. It is generally supposed that we may meet with albinos in any type of animal now to be found in existing faunæ in any part of the world; but, strange to relate, there are certain groups of animals, representatives of which seem to be exempt from it. Moreover, while we know very accurately what constitutes albinism, whether partial or complete, we do not know, in so far as I am aware, the precise cause of it, when manifested in any particular individual. There are those who are disposed to consider it simply as a 'freak of nature,' an opinion that I

cannot see my way to accept; for such an explanation stands for nothing more than a cloak to our ignorance of the basic cause of the condition. Why we should find, for example, in a brood of crows, three normally plumaged and the remaining one an albino, has not, in my opinion, ever been satisfactorily explained.

"Among American fishes I have seen living examples of albino brook trout, flounders, eels, and others; while in the case of the common or golden carp albinos are not infrequently met with in nature. Salamanders and frogs occasionally exhibit it among the Batrachians, while examples of it have been observed in the case of certain snakes, 'horned toads,' and lizards. But in so far as my personal experience goes, I have never met with an albino turtle or a tortoise, although I have seen very pallid examples of our common box-tortoise (*Terepene carolina*).

"Of all the Vertebrata birds seem to constitute the group most frequently exemplifying this condition, and I have personally examined or collected cases of complete or partial albinism, representing nearly every family of them. For the most part, this has been seen in the case of loons, gulls, ducks (teal and mallard), certain waders, sora rail, snipe, woodcock, quail, grouse, turkey, various owls and diurnal raptorial birds, whippoorwill, and in not a few passerine birds as crows, ravens, robins, bluebirds, finches, and others.

"Whilst writing this I have a fine specimen of a 'piebald' robin in my collection, which I collected in Connecticut in 1868.

"American mammals frequently afford examples of either partial or complete albinism, and a few years ago, I had, for a short time, in my possession an unusually fine living example of our common woodchuck (*Arctomys monax*). On the day following its arrival I succeeded in obtaining some fine photographic negatives of the animal, and a photograph from the best one of these is exhibited.

"Other United States mammalian albinos collected or seen by me have been examples of prairie marmots (*Cynomys*), Virginia deer, muskrat, beaver, bats, porcupine, rabbits and hares, squirrels, and some few other forms."

June 6th, 1916.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,
in the Chair.

At this meeting an informal discussion took place on the results published in the 'Biologia-Centrali-Americana,' with special reference to the zoo-geographical relations between America and Africa, of which the following is a brief résumé:—

Dr. F. DuCANE GODMAN, F.R.S., F.Z.S.—In compliance with a request from the Publication Committee of this Society, I have

made a few notes which may serve as a prelude to the discussion on the results recorded in the work published by Osbert Salvin and myself—the *Biologia Centrali-Americana*.

Salvin and I were at Cambridge together, and after leaving the University in 1857 Salvin visited Guatemala to report upon the nuts of a Palm which it was thought might be used in the manufacture of candles. The nuts, however, proved useless for practical purposes, so he devoted some months travelling about the country collecting Birds, Insects, and Plants. Salvin subsequently made three further expeditions to Guatemala with the sole object of continuing his Natural History pursuits—in 1859, and in 1861, on which occasion I accompanied him, returning after about a year's absence, and again in 1865, when he also visited Panama. We trained and employed many of the natives to assist us, and some of them continued to send us specimens for over 30 years.

Salvin and I were immensely struck and delighted with the richness and variety of the fauna and flora found in a tropical country, but it was the revolution in thought produced by the publication of the 'Origin of Species' by C. Darwin, and the promulgation of the theory of evolution, which gave such an intense interest to the subject. I well remember the violent opposition with which this new doctrine was received, and it is difficult for those of the present generation to realize the bitterness with which this new idea was received by all classes. Salvin and I had both read the 'Origin' before our visit to Guatemala, but it was not till after our return that in working out our collections the truth of the new doctrine was fully realized. From that time we took a deeper interest in all our work, and now many problems that had puzzled us were solved. Although we had written several papers in the *P. Z. S.* and *Ent. Soc. Trans.*, we were still without any idea of publishing the result of our travels in a more collected form.

In 1876 it was suggested that the 'Biologia' should be undertaken, and three years after the first part appeared. It was then estimated that the whole of the Zoology might be completed in 60 parts, but owing to the ever-increasing material this subject alone occupied 215 parts.

After we had been at work for some time we found ourselves very short of Mexican and North-American material wherewith to compare our Central American specimens, and to remedy this, in 1888 I made an expedition to Mexico and spent some months collecting in various parts of the country. For the Birds of North America I was fortunate enough to be able to purchase the Henshaw collection, which was very rich in species from the United States, and which Mr. Ridgway kindly examined for me, critically revising the names and localities. Up to this time collections of North-American birds in this country were very meagre.

A few words on the physical aspect of the country are perhaps

necessary here, but as this subject has been dealt with at length in the Introduction, I will only refer to its general characteristics. Northern Mexico consists of a high tableland, the extension of the Arizona plateau; it is very arid and consequently barren, growing cacti and other such plants. At the spot where the railway crosses the Rio Grande at El Paso, on the borders of Mexico, the plateau descends to only 3700 feet, but soon rises again and has an average altitude of about 8000 feet, till at the end of some 900 miles the City of Mexico is reached. This plateau is bounded on each side by ranges of mountains descending abruptly towards either coast and clothed with forest, which at its summit consists largely of pines and ilex. Both on the Atlantic and Pacific coasts there is a narrow belt of tropical country. About the City of Mexico the plateau is broken by a series of volcanoes, the highest of which reaches 18,000 feet. Southward to Panama the land gradually descends in altitude; it is, however, very much varied and frequently covered with forest, alternating with savannas and interspersed with many volcanoes, one of which in Costa Rica attains a height of 11,000 feet. At the Isthmus of Panama the land subsides to 300 feet.

The country is divided by the natives, according to altitude, into zones under the names of *Tierra caliente*, *Tierra templada*, and *Tierra fria*, and these zones have an immense influence on the fauna and flora, and are a largely determining factor in the number and diversity of species. The climatic conditions must also be taken into consideration, the rainfall on the Atlantic being far in excess of that on the Pacific, and the vegetation far more luxuriant.

In Eocene or early Miocene times there was a broad channel separating North and South America, where the Isthmus of Panama now exists, and it seems probable that a series of elevations and subsidences took place, temporarily forming islands before the land became permanently continuous as it now is, thus accounting for the many allied and representative species found in Chiriqui and Costa Rica.

When the channel was in existence it must have proved an insuperable barrier to the migration of land-animals, but when the two continents became united undoubtedly a considerable interchange of animal- and plant-life took place, and there was a mingling of northern and southern forms. This, no doubt, accounts for the extraordinary richness in species of Central America.

Mr. Pocock, in his remarks on the origin of the Mammalia, says that during Miocene times, when the Panama land-bridge was upheaved, the migration was divided into two categories, one containing the Insectivora, Carnivora, Artiodactyla, Perissodactyla, etc., which had been evolved in the northern hemisphere and inferentially passed from North into South America, while the other comprised the Primates, the Edentates, the Marsupials,

and part of the Rodents, which migrated from South into Central or North America. Birds, which, from their power of flight and habit of migration common to a large number of them, are much more easily distributed than most vertebrates, *do not* throw the same light on geographical distribution as is the case with more sedentary animals. This must, however, be applied in a general sense, as many of the species are extremely local. Nearly half the 1413 species are endemic; but a very large number are migrants from the United States, spending the winter in Central America and returning again in spring. There are, however, two remarkable instances which I may mention. The family of the Tinamidæ, which are essentially ground-birds, rarely fly, and are frequenters of the forest. Members of this family range from Chili to Mexico. They are of a very ancient type, probably allied to the Ratitæ, and must have passed *by land* to Central America. The Trogons, on the contrary, have a very wide distribution; they are strictly tropical, and are also frequenters of the forest, but, unlike the Tinamidæ, have a very extended range, being also found in Oriental regions, and a single species of a peculiar genus occurs in Africa. Remains of a fossil Trogon have been found in the Miocene of France.

It seems probable that South America may have had a land communication with Africa at some remote period, and America may have received some of its characteristic forms from that continent. There is also some reason to suppose that there may have been a land communication with Australia, though this seems more remote. But this is a subject which I hope may be discussed later.

As regards the Insects, which form so large a portion of the work, little can be said as to their distribution at present, and it will be well to wait till more is known of those of other countries; at present the geological evidence is but scanty.

Salvin and I had intended, on the conclusion of the 'Biologia,' to have discussed the geographical distribution of species, but in consequence of his death and my own ill-health this project was abandoned, and Mr. R. I. Pocock and Mr. Regan kindly came to the rescue and I hope will be present here to-night.

The total number of species recorded in the 'Biologia' is 38,637; of these 19,067, or very nearly half, were previously unknown. They belong to 1373 genera, and are illustrated by 1173 plates containing 18,051 species, mostly coloured.

Although the 'Biologia' contains the record of such a large number of species, it is but a fragment of what may yet be obtained. The whole work must be looked upon as only a contribution to our knowledge of the subject, and I hope it may be an incentive to others to carry it further.

Dr. H. GADOW, F.R.S., F.Z.S., illustrated his necessarily very condensed remarks by slides of maps showing the present physical features of Mexico and Central America, and of hypothetical

restorations of the distribution of land and water during previous geological epochs. Also a faunistic table.

The Neotropical and Nearctic faunas and floras do not meet at the Isthmus of Panama, but in Mexico. The isthmus was originally very much broader.

The various groups of the fauna seem to fall into three categories:—

1. Those which are of undoubted northern provenance. Some of these stop with the plateau; others descend thence into the hot lands, and most of these continue into Central—even far into South America.

2. Those which are of Southern, Neotropical provenance. Many of them have overrun Central America and extended into Mexico, where their current has, so to speak, been divided to east and west by the wedge-like plateau.

These two main categories interdigitate, with many complications. Some have become derelicts in their new home, whilst they have died out in their older home, *e. g.*, Tapirs. Others have hooked back, not the families, but genera and species rather, *e. g.* Opossums and the Tree-Porcupine *Erethizon*.

3. There is a considerable number of forms, drawn from all classes, which seem to be endemic, rather archaic, developed into what they are on the spot. They are the most interesting and most difficult to interpret.

- 3 A. Some seem to be real aborigines. 3 B. Others are neither from North America proper nor from South America. They must have come from elsewhere. Some of these puzzling groups seem to be a legacy from a more western extension of land, say from Lower California to the Galapagos and South America, analogous to the "Andines" of botanists, which date back far into the Cretaceous period.

Others point unmistakably to Mediterranean lands and to Africa. A "land-bridge" implies also coasts with all their concomitant physical features, suitable land-conditions for terrestrials and freshwater-fish, shallow seas for corals and shells, etc. Such "bridges" need not have ever existed in their entirety, being rather like changing pontoon-bridges. Such restorations rest upon circumstantial evidence; much of it will, no doubt, be ruled out of court, but there is a great deal of cumulative evidence and much that is mutually supporting (both negative and direct) presented by plants, Vertebrates, and Invertebrates, terrestrial and marine, so that the Afro-American connections are becoming more than a good workable hypothesis. The chief question is now, how long and into what geological groove did they last? Did they last long enough, say into the Oligocene, to be available for comparatively recent groups?

Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S., remarked that nearly all the vertebrates in South America which seemed to suggest a direct land-connection with the Old World through Africa, were either late-Tertiary immigrants from North America or senile members of pre-Tertiary cosmopolitan groups. Most of the resemblances in the faunas of the two countries usually noted were in animals of which the ancestry was entirely unknown. The only resemblances already explained by palæontology were due to the survival in the two southern continents of remnants or refugees of formerly widely-spread faunas, which had become extinct in the more progressive northern hemisphere. Palæontologists began to distinguish between the characters of animals which were real marks of affinity and others which were the inevitable and oft-repeated concomitants of maturity and senility in a race. It must be possible to distinguish these characters in a group of animals before the latter can be used in discussing questions of geographical distribution.

Mr. C. TATE REGAN, M.A., F.Z.S., said :—South America has a very rich and varied freshwater fish-fauna; with the exception of the Osteoglossidæ, a generalized and ancient group represented at the present day by a few remnants, it has not a single family in common with either North America or with Australia. On the other hand, three South-American families, Lepidosirenidæ, Characidæ, and Cichlidæ occur also in Africa, and the South-American Catfishes of the family Pimelodidæ are closely related to the Bagridæ of Africa and India.

If South America and Africa were one continent in Cretaceous times, and the connection between them persisted until the beginning of the Eocene, these facts would be satisfactorily explained. Alternative hypotheses are that the families common to South America and Africa were formerly marine and entered their rivers from the sea, or that they were formerly northern and migrated southwards, becoming extinct in the north. Against the former it may be urged that the Lepidosirenidæ are obviously adapted for life in fresh water and unfitted for life in the sea, that the Characidæ are Cyprinoids, a strictly freshwater group, and that if the Cichlidæ were formerly tropical shore-fishes, entering rivers, it is curious that they did not establish themselves in the southern rivers of North America. The second hypothesis is unsatisfactory, for when the slowness of dispersal of freshwater fishes is taken into account the improbability is great that several groups should have made these extended journeys, with the final result that closely related genera arrived in Africa and South America. Hydrographical changes, such as the union of rivers formerly distinct or the capture by one river of the tributaries of another, are the means by which the dispersal of freshwater fishes is accomplished; for such fishes migration appears to be difficult, survival relatively easy. No known northern fossils can be referred to these African and South

American families, and there is good evidence that the main distribution of freshwater fishes changed but little during the Tertiary. The Eocene *Priscacara*, from the Green River Shales of Wyoming, is, in my opinion, not one of the Cichlidæ; it belongs to the North-American family Centrarchidæ, and is closely related to the modern *Eupomotis*.

When we get to know something about Cretaceous freshwater fishes new light may be thrown on the problem. But for the present the hypothesis that South America and Africa were formerly one continent is the one that offers the most reasonable explanation of the relationship between their freshwater fishes.

Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., remarked that evidence for the former existence of a tropical or southern Atlantic connection between South America and Africa was supplied by the following, amongst other, genera of Arthropoda:—

PROTOTRACHEATA.—*Peripatus* is confined to tropical West Africa and tropical Central and South America and the Antilles. *Opisthopatus* is found only in Chili and Cape Colony.

DIPLOPODA.—The Spirostreptid genus *Orthoporus*, which is of wide distribution in tropical America, is very closely related to tropical African, but not to tropical Asiatic, millipedes.

CHILOPODA.—*Parotostigmus* occurs in tropical America and Africa, but not in tropical Asia. *Scolopendra* (s.s.) is mainly tropical and Central American, but in the Old World it has been recorded from the Cameroons, the Canary Islands, Arabia, and Sokotra.

SCORPIONES.—Of the three tropical American genera of the Scorpionidæ *Opisthacanthus* has its nearest ally in the tropical and South-African *Opisthocentrus*; and *Diplocentrus* and *Oiclus* are closely related to the Arabian and Syrian *Nebo*, the three together constituting the well-marked subfamily Diplocentrinæ.

ARANÆ.—The Sicariidæ (s.s.) range in America from Chili to Costa Rica, and are only found elsewhere in the world in South Africa. Of the three genera of Caponiidæ *Nops* and *Caponina* are tropical American, *Caponia* South African.

In the case of the above-mentioned Arthropods no reason can be assigned for their extermination elsewhere in the tropics, if they are the only extant representatives of genera formerly widely distributed in the Northern Hemisphere.

In the case of the Mammalia the evidence rests mainly upon the present distribution of the three following orders:—

SIRENIA.—The Manatees (*Trichechus*) are restricted to the rivers and estuaries debouching into the Atlantic on the African or eastern side and on the American or western side. These animals do not venture out to sea, and no extinct representatives of the genus appear to be known from European or North-

American deposits to support the theory of its former extension into northern latitudes.

RODENTIA.—The headquarters of the Hystricomorpha at the present time are South America, where they date back to the Upper Miocene. The only North-American representative of the group is the tree-porcupine (*Erethizon*), a late immigrant from South America. No extinct representatives of the group have been found in early or mid-Tertiary strata in North America. But in the Old World alleged representatives of the suborder, referred to the family Theridomyidæ, occur in Eocene and Oligocene deposits in Europe, and at the present time several genera of Octodontidæ occur in Africa, and the Hystricidæ range from Africa through Southern Asia to Borneo.

Until evidence for the existence of this group in early and mid-Tertiary or Cretaceous times in North America is forthcoming, it cannot reasonably be claimed that the South-American forms are descendants from ancestors from the North; and if the theory of raft-transportation from Africa be rejected, it must be conceded that the faunistic similarity between tropical America and Africa in this respect supports the idea of a transatlantic land-connection between those countries.

PRIMATES.—The past and present distribution of Monkeys is tolerably similar to that of the Hystricomorph Rodents. The Platyrrhini are restricted to South and Central America, where they date back to the Upper Miocene. No fossil monkeys have hitherto been discovered in North America. Similarly, the Catarrhini are confined to tropical and temperate countries of the Old World, and have been recorded from middle and later Tertiary deposits in Europe and Asia. The available data, therefore, point to the entry of monkeys into South America from the Old World by means of a southern transatlantic land-bridge, unless it be claimed, as it has been claimed, that the resemblances between the Platyrrhini and Catarrhini are due to convergent descent from Lemuroids of the New and Old Worlds respectively, a view from which Mr. Pocock expressed dissent.

Dr. C. W. ANDREWS, F.R.S., F.Z.S., remarked that if a land-bridge had existed between Africa and South America in Tertiary times one would expect a more extensive mingling of faunas than had actually taken place. Even in the Eocene both continents must have had a varied mammalian fauna, yet it is only claimed that the Primates, the Hystricomorph Rodents, and perhaps some Insectivora crossed from Africa to South America, no interchange in the opposite direction being known. Of these groups the Primates are represented by numerous small lemur-like animals in the Eocene of North America, and it is thence that the colonization of South America probably took place, although at present the group may be unknown from the older tertiaries of that continent. The Hystricomorph Rodents are represented in the Eocene and Oligocene of the Old World by numerous

species referable to the Theromyidæ; these are all small animals and seem to have been very abundant, so that, like the rats and mice of to-day, they would be especially liable to accidental transport. The same may have been the case with the Insectivora. What really happens when a land-bridge is established is well shown in the intermingling of the faunas of North and South America after the establishment of the Isthmus of Panama at the end of the Miocene or beginning of the Pliocene period.

LORD ROTHSCHILD, D.Sc., F.R.S., F.Z.S., said that while in no way wishing to oppose the views of the speakers who preceded him, he thought, and had always thought, that in many cases the supposed relationship of the faunas of widely separated areas was more apparent than real, and that many of the instances usually quoted were cases of convergence or parallel development. This could be easily explained if we considered that the chain of evolution of all species owed its commencement to a stimulus due to the external environment the species found itself in, causing variation to proceed in a certain direction. It is also as easily conceivable that a similar or even identical stimulus might start a chain of variation along similar or even identical lines in two totally different areas. He instanced among birds the two snipe, *Gallinago nobilis* and *macrodactyla*, the former from South America, while the latter inhabited Madagascar. These two birds are practically identical, but had evidently had separate origins. He also instanced the genus *Mænas* among the Arctiid moths, species being found in Africa, Indo-Malayana, and South America. While in the imago the structure was identical, in the larva the difference in habits pointed clearly to a separate origin, for while the larvæ of the species inhabiting the Old World were terrestrial the larvæ of the South-American species were entirely aquatic. On the contrary, he pointed out that the case of the gigantic land-tortoises favoured the views of the previous speakers, for while at present they were confined to two small groups of islands, the Aldabra and Mascarene group in the Indian Ocean and the Galapagos Islands off the South-American coast, in Miocene times they were found in many parts of the world and the present-day forms were merely survivals.

DR. R. BROOM, D.Sc., C.M.Z.S.—When I was a student 30 years ago the scientific world was so much under the spell of Russel Wallace that any one who ventured to suggest the possibility of a land-connection across what was regarded as a permanent ocean was looked upon as a dangerous heretic, and even now there are many who are apparently afraid to admit the possibility; yet, if there is one point on which we can be perfectly certain, it is that South Africa was connected by land with South America in Lower Permian times. Identical species of plants lived in the two continents, and we know enough of the floras of North America and Europe to feel sure that the species did not pass

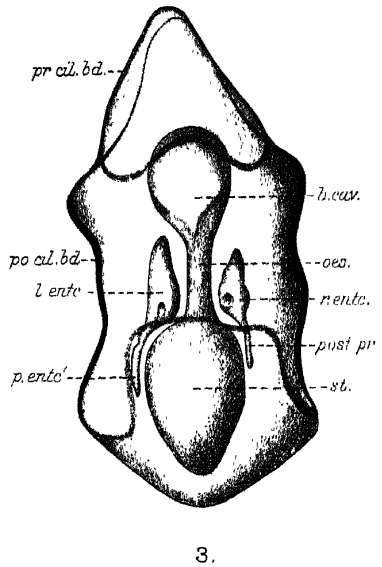
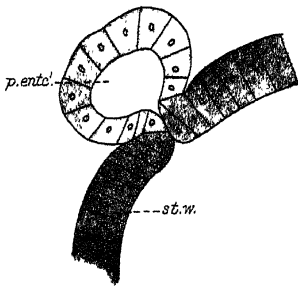
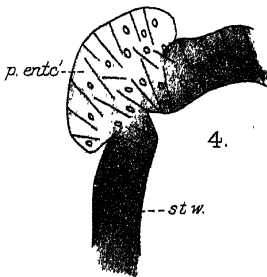
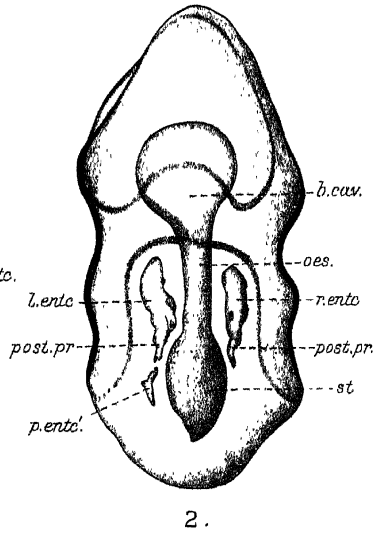
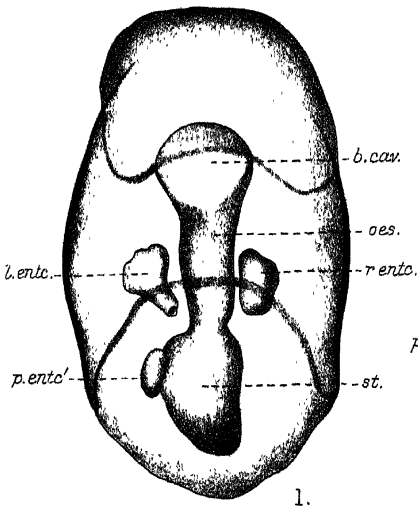
from the one continent to the other by the north. We know only a very few tetrapod vertebrates, but those known from Brazil are strikingly similar to those that occur in South Africa. A few years ago I described a new specialised Mesosaurian, *Noteosaurus*, which differed from *Mesosaurus* in having the 5th digit of the hind foot very slender and provided with six phalanges. Shortly afterwards the same peculiar type turned up in Brazil. *Mesosaurus* and *Noteosaurus* were small freshwater inhabiting reptiles which might at suitable times have passed from one river-basin to another like newts or frogs, but which could never have lived at sea. It is difficult to believe that they could have passed round either the Atlantic or Pacific by the north sufficiently quickly, even if there were no other apparently insuperable difficulties, to have appeared practically contemporaneously in South Africa and South America.

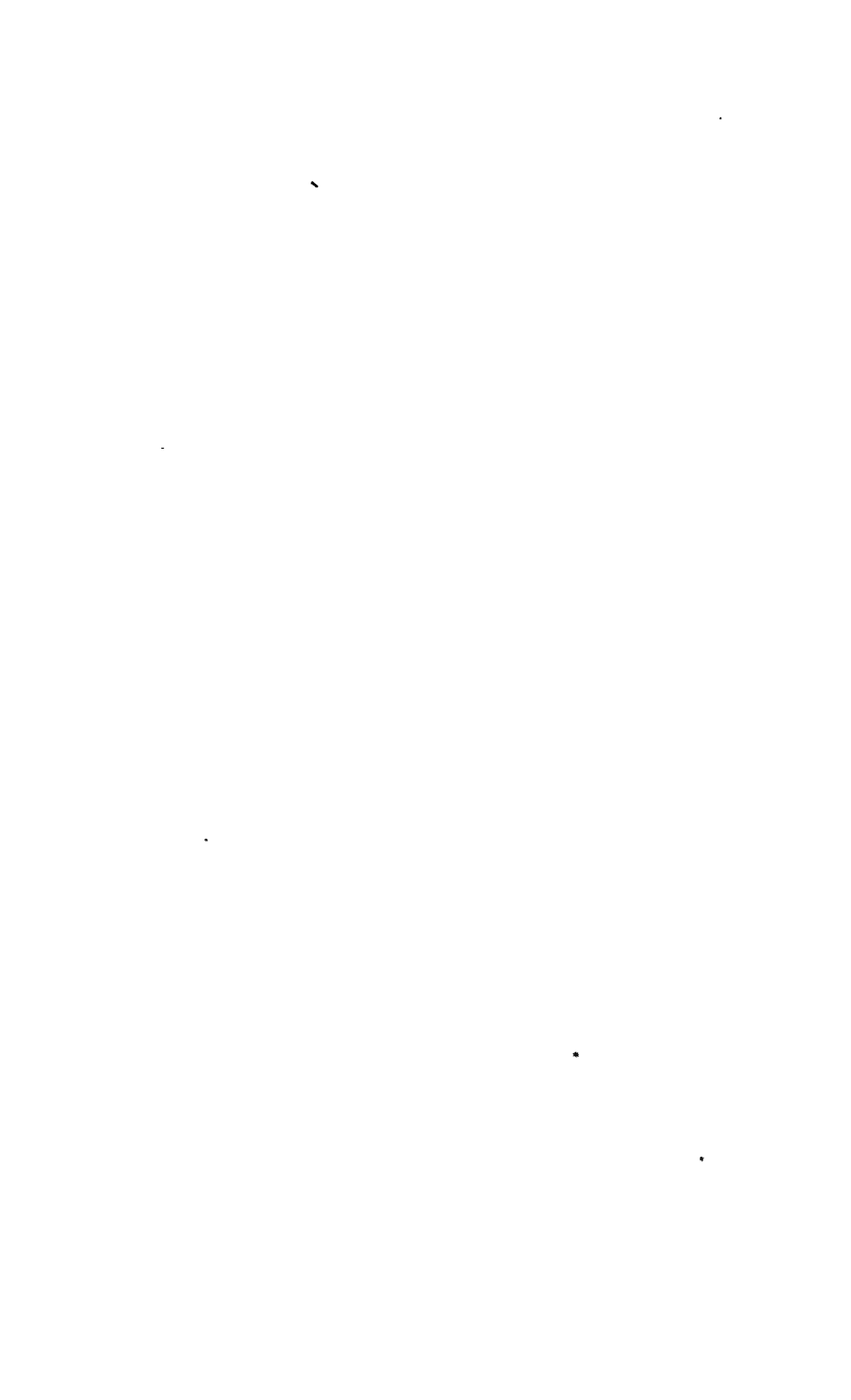
We know that in Lower Devonian times the littoral fauna of South Africa was practically the same as in the Falkland Islands. We can therefore be quite certain that the oceans are not permanent, and that what is now the South Atlantic had land stretching across it in Devonian times. We may be equally sure that much of the South Atlantic was land in Permian times. There is also good reason to believe that the land-conditions continued into the Triassic and Jurassic. If the elevated conditions continued into the Cretaceous, of which there is some direct evidence, we could have a sufficient mingling of primitive forms of life to probably account for all the known peculiarities of distribution.

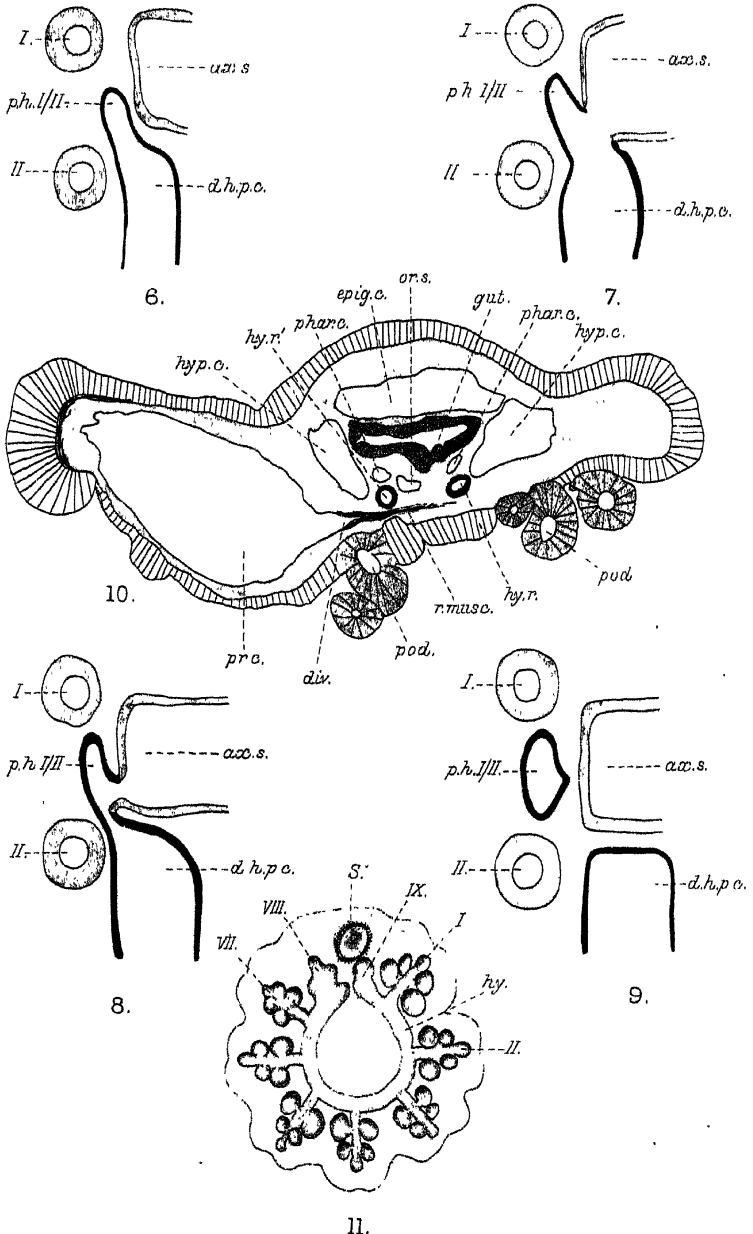
When in New York recently I had numerous discussions on the subject with Dr. Matthew, but while I am willing to admit that the evidence is rather against any Tertiary land-connection unless it be a Lower Eocene one, I have always felt strongly that there must have been a Cretaceous connection. The facts which Mr. Tate Regan has laid before us are, I think, quite inexplicable on any other hypothesis.

Mr. W. L. SCLATER, M.A., F.Z.S., said that he agreed with the last speaker, Dr. Broom, that it was quite possible to postulate the existence of a land-bridge between South America and South Africa in Secondary times, but that he believed that the present distribution of the ocean-beds and great land-masses had been continuous since the commencement of the Tertiary epoch, and that, so far as he could see, none of the difficult problems of the distribution of the higher groups, *i.e.* Mammals and Birds, required for their solution the hypothetical existence of land-bridges across the present deeper ocean-beds. He reminded his hearers that the comparatively short duration in time of the Tertiary epoch as compared with the Secondary and the Secondary as compared with the Primary, was not always taken into consideration in the discussion of these problems from a zoological standpoint.

Professor E. W. MacBride, D.Sc., F.R.S., V.P.Z.S., in winding up the discussion, pointed out that there could be no inherent improbability in the existence in Secondary times of a land-bridge connecting South Africa and South America, for there was strong stratigraphical evidence for the existence of such a bridge across the North Atlantic. On both eastern and western shores of this ocean two sets of red sandstones with intervening coal-measures, both sets being of extraordinarily similar lithological character, represented the Devonian, Carboniferous, and Permian periods. As we receded from the coast in both directions, westward in America and eastward in Europe, we found that these periods were represented by rocks of quite different lithological characters. Geologists believed that the coastal rocks were produced by the washings from a North Atlantic continent consisting of granitic rock and that this continent lasted till the close of Eocene times.







J.F. Gemmill del.

Huth, London.

6-10. CRIBRELLA OCULATA. 11. SOLASTER ENDECA.

PAPERS.

27. Notes on the Development of the Starfishes *Asterias glacialis* O. F. M.; *Cribrella oculata* (Linck) Forbes; *Solaster endeca* (Retzius) Forbes; *Stichaster roseus* (O. F. M.) Sars. By JAMES F. GEMMILL, M.A., M.D., D.Sc., F.Z.S.*

[Received May 20, 1916; Read November 7, 1916.]

(Plates I. & II.†)

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I. ASTERIAS GLACIALIS. (Pl. I.)

In the course of attempts to rear *Asterias glacialis* I have constantly noticed that in the early larvæ (6-8 days) a small mass of cells takes origin from the wall of the stomach dorsally on the left side. Although this mass usually disappears by breaking up into mesenchyme before the main cœlomic cavity has extended back into its neighbourhood, still not infrequently some of its cells can be seen to join the wall of the cœlom. It is very common for the mass in question to show traces of a central cavity after its separation from the stomach and before its disruption into mesenchyme.

A similar mass, but rather smaller and less constant, occurs in the case of *Asterias rubens* (2, p. 233), and two such masses, right and left, are frequent in the larvæ of *Porania* (3, p. 32). In all three species considerable variation in the constancy and size of the masses is exhibited by different broods of larvæ as well as by different larvæ in the same broods.

The object of the present note is to call attention to an instance in which the mass was unusually well-marked in practically all the early larvæ belonging to a particular culture of *Asterias glacialis*. Later, in a large proportion of the larvæ, the mass as it separated off from the stomach acquired a distinct lumen, and, subsequently increasing in size, fused with the cœlomic cavity of the left side, thus taking a share in the actual formation of the posterior portion of the cavity in question. Stages in the process are illustrated in Pl. I. figs. 1-5, and explained in the description attached.

* I have to express indebtedness to the Trustees of the Carnegie Trust for grants towards the expenses incurred in this investigation, as well as in that on "The Ciliation of Asterids and the Question of Ciliary Nutrition in certain Species" (Proc. Zool. Soc. Lond. 1915).

† For explanation of the Plates see p. 564

In accounts of the development of *Asterias rubens* (2, p. 233) and *Porania* (3, p. 33) I put forward the view that the mass in question is the rudiment of a posterior enterocœlic outgrowth, pointing out that the recognition of potential metamerism in echinoderm development makes for simplicity and for the reconciliation of what might otherwise seem fundamental differences in the ontogeny of different forms. (See also p. 557.)

The larvæ above described add evidence in support of this view. In any event, they deserve to be put on record since they supply a definite example of a developmental variation occurring along lines which, if persisted in, could give rise, in course of time, to very important alterations in the ontogeny, without necessarily affecting the adult anatomy, of the species concerned.

II. CRIBRELLA OCLATA. (Pl. II. figs. 6-10.)

Early in April 1915 a number of *Cribrella*, obtained at low-water on the shore near the Millport Marine Station, were placed in the aquarium tanks, where they spawned freely after a few days. The eggs, which were kindly put at my disposal by the Superintendent, underwent natural fertilization, sets of them being brought through metamorphosis both at the Marine Station and in the Embryological Laboratory at Glasgow University.

Masterman in 1902 (9) furnished an excellent account of the development of this species. My observations confirm his results in most respects, but I am able to give new or supplementary data on various points*.

(1) *Spawning*.—Not less (and probably more) than 500 eggs are produced by each full-sized female. None of the eggs was observed to enter into and remain within a brood-pouch formed by the closure of the arms around the mouth. In my specimens the genital openings look outwards in the interradial. During March and April *Cribrella* eggs or larvæ are not infrequent in the plankton of the Firth of Clyde.

Sars (10, p. 170) and Masterman (9, p. 374) have described the brooding habits of *Cribrella*, the latter pointing out that these are by no means intense, but adding that it is not known whether in natural conditions any of the larvæ leave the brood-chamber of the mother. He gives the number of eggs laid by each female as 30 to 50, and Sars as 10 to 30. Masterman also states (9, p. 374) that the genital openings are situated on the oral surface of the starfish at the edge of the oral disc, this being an adaptation for brooding.

Cribrella appears to be a species in which the brooding habit is either being acquired or being lost. The second alternative seems rather more probable, and from the evidence given above it would

* Dr. Masterman makes the very reasonable suggestion to me that the features noted under 1 and 2 below are probably explicable as adaptations to development within a relatively enclosed sea-area, such as is formed by the Firth of Clyde.

appear that the change towards loss has advanced further on the west coast of Scotland than on the east and in Norway.

(2) *Segmentation*.—Segmentation proceeded regularly in most of my specimens, equal holoblastic cleavage being the rule and not the exception. The eggs float, the pole which keeps undermost being usually a little lighter in colour than the upper pole, but there is not the same marked difference either as regards specific gravity or colour between the upper and the under poles as in the eggs of *Solaster endeca*. Masterman did not find that there was any definite or consistent type of segmentation in his ova of *Cribrella*, and he does not refer to differences in colour or specific gravity between the upper and the under sides (9, p. 377).

(3) *Blastula formation*.—The surface-furrows along which egression takes place during blastula-formation almost certainly exhibit reversion to the segmentation patterns. In the early blastula the lines are very numerous, simulating an advanced stage in segmentation; then they become fewer, simpler, and deeper, so that sometimes we cannot tell with the naked eye whether we are looking at an advanced blastula or at an 8-celled, a 4-celled, and a 2-celled stage in segmentation. Peculiarities in the arrangement of the early segmentation-furrows (*e. g.* obliquity of the first cleavage plane, or marked inequality in the first and second divisions) tend to emerge again in the late blastula, as may be seen if one watches the development of isolated ova which exhibited the peculiarities in question. I have had the opportunity of noting a similar phenomenon in the case of *Solaster papposus*, and in *Solaster endeca* (1, p. 12) I called attention to the similarity between the cell-egression furrows and the segmentation-furrows. Masterman's illustration (9, pl. i. fig. 6) of an early gastrula of *Cribrella* strikingly recalls a 4-celled stage in cleavage.

(4) *Hypenchyme*.—In my gastrulae and early larvæ there was only a small quantity of cellular material within the archenteron, less than one-fourth of this cavity being filled with the material in question (*cf.* *Solaster*, 1, p. 45). Masterman describes the archenteron during these stages as being entirely filled with hypenchyme (9, p. 381).

(5) *Pharyngeal or perioral cœlom*.—I can confirm the observation of Masterman that this cœlom arises in the form of interradiial pouchings from the posterior cœlom, and can add further that such pouchings occur in interradii I.-II. and I.-V.* as well as in the others, a point regarding which Masterman did not speak with certainty (9, p. 416).

The pharyngeal cœlom arises by a single outgrowth in *Asterina* (7, p. 358) and *Asterias rubens* (2, p. 259), as also in *Ophiothrix* (8, p. 497) and *Synapta* (8, p. 536). On the other

* The numbering of rays adopted in this paper is that employed by MacBride in his account of the development of *Asterina*, and by myself in the case of *Solaster*, *Asterias*, and *Porania*. The madreporic radius is I.-II., ray II. being on its dextral or watch-hand side as viewed from the oral aspect.

hand, in *Solaster* (see p. 560) it takes origin by a series of inter-radial outgrowths as in *Cribrella*.

(6) *The perihæmal pouches*.—Perihæmal pouch I./II. has been described (Masterman, 9, p. 392) as taking origin from the axial sinus portion of the anterior cœlom, being thus exceptional inasmuch as the rest of the pouches take origin from the posterior cœlom. I find that the exception is apparent, not real, and that actually the pouch in question arises from the dorsal horn of the posterior cœlom. At about the eleventh day the tip of this horn bends leftwards, thus coming to lie between hydrocœle pouches I. and II. A day or two later an opening is effected between the axial sinus region of the anterior cœlom and the dorsal horn of the posterior cœlom a short distance back from the tip of this horn. Two or three days afterwards the anterior cœlom and the dorsal horn of the posterior cœlom again become closed off from one another, but in such a manner that the new septum cuts off the tip of the horn and leaves it for a time connected with the anterior cœlom, from which, however, it soon separates off to become perihæmal pouch I./II. The process is illustrated on Pl. II. figs. 6–9. Occasionally one finds that the perihæmal pouch in question remains longer in open connection with the posterior than with the anterior cœlom.

MacBride (7, p. 360) and Goto (5, p. 235) in *Asterina*, and Masterman (9, p. 392) in *Cribrella*, described perihæmal pouch I./II. as arising from the preoral cœlom. However, in *Solaster endeca* (1, p. 35), *Asterias rubens* (2, p. 260), *Asterias*, double hydrocœle (4, p. 64), I found that the pouch arose from the dorsal horn of the left posterior cœlom, although, owing to the communication between dorsal horn and axial sinus, it appeared at first sight as if the pouch in question took origin from the last-named cavity. In *Solaster endeca* (1, p. 35) and, I can now add, in *Solaster papposus*, the origin of pouch I./II. from the posterior cœlom is perfectly definite. In *Asterina*, as in *Cribrella*, there is a secondary communication between the dorsal horn of the posterior cœlom and the axial sinus.

(7) *Whether the larval posterior cœlom is morphologically single or double*.—So far as I can judge, in my early larvæ of *Cribrella* there are no signs of doubling of the larval posterior cœlom. Later, any features which could be interpreted in this sense affect chiefly the dorsal and ventral horns, and appear at a time when the natural differentiation of these horns leads to their dividing more or less into right and left forks. In the case of the dorsal horn the leftward fork is at first the only one to appear, and it becomes perihæmal pouch I./II. as described above under 6. From the right one, which appears later, there arises pharyngeal pouch I./II., the genital pocket, and ultimately also the cœlom within arm-rudiment II. In the case of the ventral horn, the leftward fork burrows to the left or oral side of the stalk of the preoral lobe in order to reach the internal aspect of hydrocœle pouch I., while the right fork passes to the aboral side of the

stalk in question. The two forks thus ride saddlewise on the preoral lobe-stalk, but when this stalk is obliterated, the saddle-cavity simply fills out to form the cœlom within arm-rudiment I. Further, in general, during the growth of the larva, as the epigastric cœlom remains relatively small, the larval posterior cœlom has to encroach somewhat on the right or aboral side, and in particular sections the encroaching shelf may give an impression of bifidity.

Masterman described indications of early doubling of the posterior cœlom, and considered these as supporting his view that the cœlom in question is made up of right and left morphological elements, namely, a right posterior and a left posterior cœlomic cavity. This view, although it might suit the ontogeny of *Cribrella*, is out of harmony with the data from other starfishes and from echinoderms generally, including double-hydrocœle specimens. In discussing the subject elsewhere (2, p. 234; 3, p. 32) I have put forward the view that the larval posterior (future hypogastric) cœlom of *Solaster* is morphologically a left posterior cœlom originating from the gut by a separate, metamERICALLY posterior, outgrowth, and that the corresponding cavity on the right side, namely the epigastric cœlom, originates, as in *Asterina*, *Asterias*, *Echinus*, etc., by backward extension of the anterior cœlom.

(8) *Sequence in formation of hydrocœle pouches*.—The first thickenings for the hydrocœle pouches make their appearance at about the ninth day, pouch I. being slightly the latest. Thereafter, pouches III. and IV. differentiate a little more quickly than the rest; pouch V. and pouch II. are next in order; while pouch I. is the slowest. According to Masterman the growth series usually begins with pouch V. (his pouch I.) and gradually works round to pouch I. (his pouch V.). The facts are of interest in connection with the question as to what is the proper numbering of the rays in *Cribrella* and other starfishes (2, p. 276).

(9) *Enantiomorphic and double-hydrocœle larvæ*.—Masterman has stated (9, p. 403) that enantiomorphic specimens, *i. e.* specimens in which the hydrocœle develops on the right instead of the left side of the larvæ, are probably not uncommon in *Cribrella*. None, however, was observed in my series. Indeed, in very large numbers of starfish larvæ examined from time to time (*Asterias rubens*, *Solaster papposus*, *S. endeca*, *Porania*) I have not come across a single example of this abnormality, and only one specimen (*Porania*) in which a right instead of a left hydropore was present.

No double-hydrocœle or double-hydropore larvæ were found in *Cribrella*, although examples of these abnormalities are not infrequent in other starfishes (4, p. 69).

(10) *The brachiolarian notches*.—A special gap or notch (oral brachiolarian, or hydrocœlic, notch) between pouches I. and V., such as occurs so markedly in *Asterina*, *Asterias rubens*, and *Solaster*, is not characteristic of *Cribrella*. Nor is there at any

stage a gap or wide separation (aboral brachiolarian notch) between arm-rudiments I. and II. of the disc. Arm-rudiments I. and V. are, however, kept apart for a time during the retraction of the preoral lobe towards the oral side of the disc, through having between them that region of the preoral lobe which carries the right lateral brachium.

A hydrocœlic (oral brachiolarian) notch between pouches I. and V. is characteristic (*a*) of feeding attaching brachiolarian larvæ, e. g., *Asterias rubens* (2), *Asterias pallida* (5), *Porania* (3); (*b*) of forms proximately derived from these, e. g., *Asterina* (7); (*c*) of multiradiate forms in which the extra rays are added to one or both ends of an open hydrocœle crescent, e. g., *Solaster endeca* (1) and *S. papposus*. On the other hand, absence of a marked hydrocœlic notch is characteristic of (*a*) non-attaching feeding bipinnariæ of the *Bipinnaria asterigera* type; (*b*) quinque-radiate forms with abbreviated ontogeny, e. g., *Cribrella* and *Asterias mülleri*. The presence or absence of a well-marked aboral brachiolarian notch obeys similar rules, but we must note that this notch when present occurs between arm-rudiments I. and II., not I. and V., of the disc.

(11) *Relation of hydrocœle to larval stalk.*—In *Asterias rubens* at metamorphosis, retraction of the preoral lobe to the oral aspect of the disc takes place rapidly through the action of muscular fibres developed beneath the ectoderm and in the celomic walls. In *Solaster* the process, though slower, is effected by muscular fibres which pass from the wall of the preoral cœlom to the oral aspect of the disc. In both cases the gap (see under 10 above) between the dorsal and ventral horns of the hydrocœle crescent allows the stalk to be dragged into the concavity of the crescent and to be clasped for a time by the hydrocœle ring as the latter is completing itself. In *Cribrella* the hydrocœle, being practically from the first a small complete ring or disc, does not have the chance of enclosing the larval stalk. However, a set of retractor muscle-fibres similar to those in *Asterias* and *Solaster* makes its appearance at metamorphosis, passing to the centre of the oral surface superficially to the hydrocœle and dividing into branches, some fibres from which pass deeply towards the wall of the gut, while others diverge interradially. At the place where the retractor muscle arises from the wall of the preoral cœlom, a slight outpouching can be recognised as early as the 12th day, and later (18th day) a very distinct pocket from the preoral cœlom passes towards the centre of the disc in interradius I./V. (see Pl. II. fig. 10). Had the hydrocœle in *Cribrella* been an open crescent instead of a closed ring, the retractor fibres above-described would in all likelihood have drawn the stalk and its cavity within the grasp of the hydrocœle crescent, as occurs in *Asterias*, *Asterina*, and *Solaster*. We must look upon the early closed condition of the hydrocœle in *Cribrella* as less primitive than its open formation in *Asterias*. In the latter, it seems entirely probable that the ontogenetic

retraction of the preoral lobe and its incorporation with the oral surface of the starfish repeat the phylogenetic changes in virtue of which, after fixation, the preoral lobe disappeared and the mouth, with the œsophagus, migrated to the centre of a disc-like area which gradually developed radial symmetry. *Asterina* shows a corresponding but less perfect repetition in which the larval mouth and œsophagus are temporary non-functional structures. *Solaster* has no larval mouth or œsophagus at all, but the retractor muscle-fibres of the preoral lobe are present and the hydrocele during retraction forms an open crescent. *Cribrella* is still further modified: larval mouth and œsophagus do not occur and the hydrocele is never an open crescent. However, the retractor muscle-fibres and the position of sucker and last remnants of the preoral lobe in interradius I./V. remain as primitive characters still decipherable on the developmental palimpsest of the most crucial period, namely the fixation period, in its ancestral history.

(12) *Changes of shape in starfish larvæ.*—The larvæ of echinoderms in general, and starfishes in particular, undergo remarkable changes of form sometimes quickly, sometimes slowly. These changes are no doubt due in chief part to unequal growth, but there is evidence that contraction of muscular fibres developed *ad hoc* also plays a part. Thus, as seen above, the abrupt alteration of form at metamorphosis, including the retraction of the preoral lobe, is due to muscular action. I believe that a similar factor operates in many other changes of form if we could only follow out the process. For example, the pulling down of the wall of the gut towards the middle of the oral surface to form the adult mouth appears to be due to an extension of fibres from the preoral lobe retractor set (see under 11 above). Fibres from this set pass out interradially, and probably in the end these form the dilating fibres of the mouth which lie within the buccal membrane and are attached to ridges on the mouth-angle plates. Phylogenetically, the retractor fibres of the preoral lobe may be referable to a particular segment of mouth-dilator fibres which became hypertrophied, in order at the proper time to be able to drag the preoral lobe after the larval mouth when the latter migrated to the middle of the starfish disc.

The primary division of the archenteron into anterior, middle, and posterior regions takes place somewhat suddenly and without there being any corresponding external division of the larva into anterior, middle, and posterior segments. At this time muscular tissue has not yet become differentiated, but one may note, in the basal portions of the cells lining certain regions of the archenteron, a staining reaction similar to that given by muscular fibrils. This appears very markedly in the middle or enteric region where narrowing of the archenteron is taking place, and I think it possible that the staining indicates specially contractile protoplasm present for the purpose of producing the required

change of shape without delay. This contractile protoplasm may perhaps be compared with the myonemic layer in the cortex of many protozoa.

(13) *Skeleton*.—My material has not allowed me to make a full study of the development of the skeleton, but the following points may be noted :—

1. The aboral skeleton arises in the form of scattered plates which, as in the case of *Solaster*, do not exhibit a definite radial and interradial arrangement as do the primary plates of most other echinoderm larvæ. In particular, there is no single terminal plate at the end of each ray, but a number of small ossicles, one or more of which may be in the middle line of the ray, while the others are more laterally placed.

2. The adult has a large terminal plate at the end of each ray. Each of these plates arises by fusion of a number (not less than five) of the small first-formed ossicles. This appears to be a point of very considerable interest. The symmetrical arrangement of the primary plates in typical starfish development must be an acquired feature, a result, not a precursor, of general radiate symmetry. We can hardly doubt but that in the first echinoderms the skeletal ossicles were diffusely distributed in the dermis. In *Cribrella* accordingly, whether through survival or reversion, the primitive mode of origin of the primary plates by coalescence of scattered calcifications is still exhibited in the development of the terminals.

It will be shown later (p. 562), with reference to the mouth-angle and first ambulacral plates in *Solaster*, that the converse ontogenetic process, namely, division of an originally continuous calcification into two or more movably articulated ossicles, can occur.

III. SOLASTER ENDECA. (Pl. II. fig. 11.)

Examination of material recently obtained from the Millport Marine Station enables me to supplement or correct my former account of the development of this species in regard to the following points :—(1) origin of pharyngeal or perioral cælom ; (2) origin of perihæmal pouch IX./I.*; sequence in formation of hydrocœle pouches and final position of remains of sucker ; (4) formation of the terminal, first ambulacral, and mouth-angle ossicles.

1. *Pharyngeal or perioral cælom*.—This cælom originates by interradial outgrowths from the posterior cælom, and normally such outgrowths occur in all the interradia, those in VIII./IX. and IX./I. being the latest to form. Sometimes, however, blanks appear to be left in one or more interradia, these blanks in the end being filled up by extensions from adjacent pouches.

Masterman, in *Cribrella* (9, p. 392), first described the formation of the pharyngeal cælom by interradial pouches from the

* See footnote on p. 555.

posterior cœlom, stating that this occurred for certain in inter-radii II./III., III./IV., and IV./V. In my former account (1, p. 34) I noted the occurrence of several interradiial outgrowths in *Solaster endeca*, but was unable to say whether such outgrowths were present in all the interradii. It may be added here that *Crossaster papposus* falls into line with *Solaster endeca* as regards the origin of the pharyngeal cœlom, except that in *Crossaster* the latest formed pouches are IX./X. and X./XI. (See p. 563.)

2. *Origin of perihæmal pouch IX./I.*—Formerly I thought that this pouch took origin from the anterior cœlom (1, p. 31), a moiety being possibly contributed by the posterior cœlom. Examination of fuller material brings out the fact that the whole of the pouch in question arises from the ventral horn of the posterior cœlom. (See p. 556.)

3. *Sequence in formation of hydrocœle pouches, etc.*—In *Solaster endeca* the usual number of rays is nine, and of these five are primary in the sense that they correspond to the five rays of an ordinary starfish such as *Asterina gibbosa* or *Asterias rubens*. To begin with, the five primary hydrocœle rays or pouches are arranged in a crescent with dorsal and ventral ends, pouch I.* being near the dorsal and pouch V. near the ventral end. The formation of the additional rays begins at the ventral end of the crescent, pouches VI., VII., and VIII. being successively added in this region during the progress of metamorphosis. In specimens with only eight rays the hydrocœle ring now closes in interradius VIII./I., and it is in this interradius also that the last remains of the sucker and stalk are to be found. Formerly I believed that in specimens with nine rays (the usual number) pouch IX. was superadded to pouch VIII. at the extreme ventral end of the hydrocœle crescent. However, examination of my new material and re-examination of my former material makes it certain that normally pouch IX. is superadded to pouch I. by outgrowth from the dorsal end of the hydrocœle crescent, and that accordingly the closure of the hydrocœle ring really takes place in interradius VIII./IX., the last remains of sucker and stalk being found either in this interradius or opposite pouch IX. I take this opportunity of correcting my former mistake, which was made somewhat easy by the circumstance that a large proportion of my metamorphosing specimens developed only eight pouches, pouch IX. being absent, and it was from serial sections of these specimens that my description of the details of closure of the hydrocœle ring was chiefly made. However, the correction in no way invalidates my numbering of the rays in *Solaster*, rays I., II., and V. being fixed by the two great landmarks of starfish asymmetry, the position of the madreporite and of the anus. As regards *Crossaster papposus*, we may note here that two or even three out of its six to eight extra pouches are formed by extension from the dorsal end of the hydrocœle crescent.

* See footnote on p. 555.

4. The terminal, the first ambulacral, and the mouth-angle ossicles show certain very interesting features in earlier or later development.

Terminals.—Usually the first indication of the terminal in each ray is a pair of small calcifications, to which a third (median) is frequently added, while others appear later at the sides. The adult terminal is formed as in *Cribrella* (p. 560) by fusion of a number (probably usually five) of these early calcifications. This has taken place by the time the young starfish is 3 mm. in diameter.

Ambulacral Skeleton.—In each ray on each side of the middle line, a skeletal plate develops (a) proximal to the first sucker-foot, (b) between the first and second sucker-feet, and (c) between the second and third sucker-feet, and so on in order. In my paper on the development of *Solaster endeca* I followed Ludwig (6) in numbering these as the first, second, and third ambulacrals (A_1, A_2, A_3), and also in reckoning the mouth-angle plates as being the first of the adambulacrals (Ad_1 , Ludwig). The A_1 plates give rise to what are usually called in the adult the proximal processes of the first ambulacral vertebræ. Careful examination, confirmed by slow maceration experiments, shows that both in *Solaster endeca* and in *Crossaster papposus* the mouth-angle plates (Ad_1 , Ludwig) are usually continuous in their calcification with the corresponding A_1 plates. The joint which separates them in the adult must therefore be of secondary formation. In view of the circumstance just noted, and of the further facts (1) that palæozoic Asterozoa have no ambulacral bars proximal to the first sucker-feet (Spencer, 12, p. 30), (2) that in many recent starfish the two ambulacral bars in this position in each ray are somewhat widely separated, (3) that each A_1 plate when it first appears is nearer a mid-interradial than a mid-radial line, we may raise the question whether the proximal processes of the first ambulacral vertebræ are not phylogenetically buttress-extensions from the mouth-angle plates towards the middle line of the ray. This view assumes that ontogenetically the formation of the buttress-extension is now somewhat antedated as compared with that of the mouth-angle plate. Such "heterochronicity" is by no means uncommon in other life-histories.

IV. STICHASTER ROSEUS.

The Stichasteridæ and the Asteriidæ are included by Sladen among the cryptozonates (11, p. xxxvi). They agree in the general details of their internal anatomy as well as (1) in having the gills not confined to the purely abactinal surface, (2) in having quadriserially arranged sucker-feet, (3) in having the actinostomial margin formed by the ambulacral plates, (4) in having pedicellariæ both of the forcipiform and of the forciform type. They differ, however, in that among the Stichasteridæ the marginals are fairly definite and touch one another, while the plates of the abactinal skeleton are tessellate, and arranged more

or less definitely in longitudinal rows. The Asteriidae, on the other hand, have inconspicuous marginals, and the ossicles of their abactinal skeleton form a reticulum.

Stichaster roseus is by no means abundant in the Firth of Clyde, and only one facultatively ripe specimen, a female, was available to me last summer (1915).

The ovaries resemble those of *Asterias rubens* or *A. glacialis*, each being a single, simply-branched, much lobulated sac lying free within the body-cavity except at its root, where the single efferent duct joins the body-wall.

The eggs are small like those of *A. rubens*, pale in colour, but with a reddish tinge. They were unripe when first shredded out into sea-water, but underwent the maturation changes shortly thereafter.

Cross fertilization with *Asterias glacialis* sperm was tried, and proved so far successful that about 10 per cent. of the eggs exhibited membranes of fertilization, and a number proceeded to develop until the earliest bipinnarial stage was reached. From what we know about crossing in starfish, we may infer that the normal development of *Stichaster* will follow the same course as that taken by the young hybrids.

In these segmentation was of the total and equal type, though a slight difference in size between the cells of the upper and lower pole was present as in *Asterias rubens* and *Porania*. The blastula was a hollow sphere, its wall being formed by a single layer of cells, while its central cavity contained no mesenchyme. It progressed with the upper pole in advance, and rotated at the same time in the solar or watch-hand direction as viewed from this pole.

Gastrulation was by simple invagination as in *A. rubens*, and the gastrula progressed and rotated in the same manner as the blastula. When invagination was nearly complete, stellate mesenchymal cells began to be budded off from the blind end of the archenteron. Meantime the gastrula was elongating, and there next appeared on what was to be its ventral side a slight depression bounded in front and behind by the developing transverse portions of the preoral and postoral ciliated bands. These bands became defined in the same manner as in *A. rubens*, and there was a similar correspondence in the mode of formation of the enterocœlic sacs, the hydropore, the mouth, and the regions of the alimentary canal. An interesting point noted was that the posterior enterocœlic outgrowth, which is represented more or less definitely in *A. rubens*, *A. glacialis*, and *Porania* (see p. 553), could not be made out. Unfortunately my young bipinnariæ did not differentiate further. We may, however, infer that had they done so, the result would have been a brachiolarian larva with sucker-attachment during metamorphosis.*

* A pure culture was obtained this year (May 1916). Development proceeded along the lines described above, but again I did not succeed in getting the later bipinnarial stages. Many of the larvæ showed (9th day) posterior enterocœlic bodies similar in origin and fate to those of *Asterias rubens*.

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EXPLANATION OF THE PLATES.

PLATE I.

Asterias glacialis.

- Fig. 1. Larva, 8 days old, showing on left side a well-marked posterior body becoming separated off from the wall of the stomach.
- Fig. 2. Larva from same brood, 12½ days old, showing the posterior enterocœlic body now separated off from the stomach, possessing a lumen of its own, and increasing in size. The right and left enterocœles are growing backwards along the sides of the stomach. This larva, like many others in *A. glacialis*, has a right as well as a left hydropore.
- Fig. 3. Larva from same brood, 15 days old, showing the posterior enterocœlic body now united with the main enterocœle on the left side. This larva also has two hydropores, but the right one is becoming reduced. In older larvæ the celom extends still further backwards on the sides of the stomach as in *Asterias rubens* (2), but it is then no longer possible to tell on the left side what portion is derived from the posterior enterocœlic body.

Fig. 4. Section of stomach-wall of 8 days larva through posterior enterocœlic body, which is here shown as a thickening with slight outpouching of the stomach-wall.

Fig. 5. Section of 10 days larva in similar region, showing posterior enterocœlic body with a distinct lumen, and now nearly separated off from wall of stomach.

b.cav., buccal cavity; *l.entc.*, left enterocœle; *oes.*, œsophagus; *p.entc.*, posterior enterocœlic body; *po.cil.bd.*, postoral ciliated band; *post.pr.*, posterior backwardly growing process of enterocœle, which normally gives rise to the posterior enterocœle on either side; *pr.cil.bd.*, preoral ciliated band; *rect.*, opening of rectum; *r.entc.*, right enterocœle; *st.*, stomach; *st.w.*, stomach-wall.

PLATE II.

Cribrella oculata.

Figs. 6-9. Diagrams illustrating mode of origin of perihæmal pouch I./II. from posterior cœlom.

In fig. 6 the tip of the dorsal horn which is destined to become perihæmal pouch I./II. is bending leftward to lie between hydrocœle pouches I. and II. In fig. 7 an opening has appeared between the axial sinus and the dorsal horn of the posterior cœlom. In fig. 8 the axial sinus is again becoming closed off from the dorsal horn of the posterior cœlom, but in such a way as to leave the tip of the dorsal horn still for a time connected with the axial sinus. In fig. 9 this tip, *i.e.* perihæmal pouch I./II., is seen isolated both from the axial sinus and from the posterior cœlom.

I. and II., the first and second hydrocœle pouches respectively. *ax.s.*, axial sinus portion of anterior cœlom; *d.h.p.c.*, dorsal horn of posterior cœlom; *ph.I./II.*, perihæmal pouch I./II.

Fig. 10. Section along preoral lobe and through disc of a 20 days *Cribrella* larva at a stage when retraction of the preoral lobe is in active progress (outlines drawn with *camera lucida*). The retractor muscle described in the text is seen to cause a sharp pouching of the preoral cœlom towards the disc superficial to the hydrocœle ring. Had this portion of the hydrocœle ring been absent through the hydrocœle being an open crescent, the condition in *Solaster* or in *Asterina* and *Asterias* might well have resulted, the preoral cœlom becoming continuous with the axial sinus and with the developing internal perihæmal sinus on the oral aspect of the disc, as in *Solaster*. If completion of the hydrocœle ring supervened prior to the disappearance of this continuity, the result might well be an enclosure of the stalk-cavity by the hydrocœle such as occurs in *Asterina*, *Asterias rubens*, and *Solaster endeca*.

div., pouch from preoral cœlom caused by pull of the preoral lobe retractor muscle (*r.musc.*); *epig.c.*, the epigastric cœlom; *gut.*, the enteron or gut; *hyp.c.*, hypogastric cœlom (larval posterior cœlom); *hy.r.*, the hydrocœle ring (in neighbourhood of pouch III.); *hy.r.*, the hydrocœle ring (between pouches I. and V.); *or.s.*, internal oral circular sinus (internal perihæmal ring); *phar.c.*, pharyngeal cœlom; *pod.*, developing sucker-feet; *pr.c.*, preoral cœlom; *r.musc.*, retractor muscle of the preoral lobe.

Solaster endeca.

Fig. 11. Specimen in late metamorphosis, from oral side, showing origin of hydrocœle pouch IX. from the (larval) dorsal end of the hydrocœle crescent (see p. 561). Contrast with Pl. i. fig. 13 of *I.*, in the lettering of which, however, VIII. and IX. should be replaced by VII. and VIII. respectively.

28. On Cryptostome Beetles in the Cambridge University Museum of Zoology. By S. MAULIK, B.A. (Cantab.), F.E.S., Imperial College of Science and Technology, London *.

[Received May 22, 1916 : Read October 24, 1916.]

(Text-figures 1 & 2.)

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The present paper is based on the collection of Hispinæ and Cassidinæ contained in the Museum of Cambridge University. The collection is a representative one, in that it is composed of species from all parts of the world. There are 271 specimens representing 14 genera and about 40 species of Hispinæ and 34 genera and about 68 species of Cassidinæ. Owing either to the imperfect condition of the specimens or to insufficiency of material, I have been able to deal with only 47 genera and 80 species of both groups in this paper.

I have studied this collection in conjunction with similar material in the British Museum (Nat. Hist.). This method has afforded me the opportunity of examining a large number of examples, with the result that I have been able to study critically some of Boheman's genera and to propose some alterations. I have also been able to supply information on certain points which are left as doubtful in Spaeth's recent 'Catalogue of Cassidinæ.' In a few cases the priority of the names of certain genera has been discussed. Three new genera, one new subgenus, and two new species are now proposed here. In the following list of determinations wherever the range of a species is not indicated it has been reported only from the locality which is mentioned in this paper.

I wish to express my indebtedness to Dr. C. J. Gahan, who has always kindly given me the benefit of his opinion on many points. My thanks are also due to Mr. Scott, of the Cambridge Museum, whose assistance at the initial stage of the study I wish to acknowledge. This piece of work was done while I was a student of the Imperial College of Science. I take this opportunity of expressing my thanks to Profs. MacBride and Lefroy, of the zoological department of the College.

* Communicated by the SECRETARY.

AMERICAN HISPINÆ.

Genus CEPHALOLEIA Chevrolat.

Chevrolat, Charles d'Orbigny's Dict. Universal d'Hist. Naturelle, iii. 1843, p. 272; Blanchard, Hist. Ins. ii. 1845, p. 182; Baly, Cat. Hisp. 1858, p. 39, t. 1. f. 12; Chapuis, Gen. Col. xi. 1875, p. 277; Weise, Arch. f. Naturg. 1910, p. 82.

Baly, in his 'Catalogue of Hispidæ,' refers to *Cephaloleia* as a manuscript name of Chevrolat's. This statement has been accepted by Weise, who ascribes the authorship to Blanchard, whose characterization of *Cephaloleia* was published in 1845. Chapuis ascribes the authorship to Chevrolat, but gives a reference to Dejean's Catalogue, 3rd ed. 1836, p. 390, where the genus is not characterized. This reference naturally leads one to think that Chevrolat did not characterize the genus. As a matter of fact, Chevrolat first characterized the genus in d'Orbigny's 'Dictionnaire Universel d'Histoire Naturelle,' iii. January 1843, p. 272, in these words:—"Ces insectes ont un peu du faciès des Cassidairens, mais ils sont étroits, quelquefois allongés carrément, entièrement lisses, sans épines; leur corselet est ou arrondi en avant et sur les côtés, ou en carré transverse. Les *Hispa metallica*, *nigricornis*, Fabr., l'*Hisp. nigricornis* d'Olivier, espèce distincte de la première, et l'*Alurnus cyanipennis* de Perty rentrent dans ce genre." This description is signed C. There are various dates on the title-pages of d'Orbigny's 'Dictionnaire.' The question of these dates has been gone into by Sherborn and Palmer (Ann. Mag. N. H. (7) iii. April 1899, pp. 350-2). According to them the third volume of d'Orbigny's 'Dictionnaire,' in which the description of *Cephaloleia* occurs, was first published as a completed volume in January 1843. I have consulted the copy belonging to the Zoological Society of London, the title-page of which bears the same date.

Weise has changed the spelling of the name of the genus by omitting the "e" between the "l" and "i." I prefer to adhere to Chevrolat's original spelling, because this custom of latinising the names has led to great confusion in many cases.

CEPHALOLEIA NIGRICORNIS Fab.

Cephaloleia nigricornis Fabricius, Ent. Syst. i. 1792, pt. 2, p. 73; Olivier. Encycl. Méth. vii. 1792, p. 99, Ent. vi. 1808, p. 773, t. 2. f. 25; Baly, Cat. Hisp. 1858, p. 47.

3 examples.

Locality.—Amazons (Goodman, 1879).

CEPHALOLEIA PROXIMA Baly.

Cephaloleia proxima Baly, Cat. Hisp. 1858, p. 47.

1 example.

Locality.—Amazons (Goodman, 1879).

Baly reports it from Cayenne, Guiana.

CEPHALOLEIA EXIMIA Baly.

Cephaloleia eximia Baly, Cat. Hisp. 1858, p. 53.

2 examples.

Locality.—Amazons (*Goodman*, 1879).

Baly reports it from Cayenne, Guiana.

Genus STETHISPA Baly.

STETHISPA CONFUSA Baly.

Stethispa confusa Baly, Ann. Mag. Nat. Hist. (3) xiv. 1864, p. 267.

1 example.

Locality.—Amazons (*Goodman*, 1879).

Genus CHALEPUS Thunb.

CHALEPUS (CHALEPUS) SANGUINICOLLIS L.

Hisp. sanguinicornis Linné, Mant. Plant. Alt. vi. 1771, p. 530.

2 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Middle and South America.

OLD WORLD HISPINÆ.

Genus BOTRYONOPA Blanch.

BOTRYONOPA SPECTABILIS Baly.

Botryonopa spectabilis Baly, Cat. Hisp. 1858, p. 93; Gestro, Ann. Mus. Stor. Nat. Genova, 1897, p. 44.

2 examples.

Locality.—Malay Penin. (*Sheat Expedition*, 30. xi. 1899).

Range. Malacca, Sumatra.

BOTRYONOPA GRANDIS Baly.

Hispopria grandis Baly, Cat. Hisp. 1858, p. 95.

1 example.

Locality.—Borneo (*Shelford*).

Range. Sumatra, Java.

Genus ANISODERA Chevrolat.

Chevrolat, C. d'Orbigny's Dict. Univ. d'Hist. Nat. i. 1847, p. 535; Baly, Cat. Hisp. 1858, p. 101, t. 2. f. 8; Chapuis, Gen. Col. xi. 1875, p. 295; Weise, Deut. Ent. Zeit. 1897, p. 118.

The authorship of this genus must be attributed to Chevrolat and not to Baly, as has hitherto been done. It was an oversight on Baly's part to call *Anisodera* a manuscript name. In Charles d'Orbigny's 'Dictionnaire,' i. p. 535, *Anisodera* is described as follows:—"Genre de Coléoptères tétramères, famille des Chrysomélines, tribu des Hispoides, établi par M. Chevrolat aux dépens

du g. *Alurnus* de Fabricius, et adopté par M. Dejean (Cat. 3^e edit.), qui y rapporte deux esp. de Java, savoir : l'*A. lucidiventris* Buquet, et l'*A. ferruginea*, qui est l'*Alurnus ferrugineus* de Fabr.—Les caract. de ce g., d'après M. Chevrolat, sont : Tête avancée, arrondie, entaillée circulairement sur la face. Palpes assez développés : le dernier article des maxillaires long, un peu renflé au milieu. Antennes presque réunies par la base sur le front, épaisses, cylindroïdes, de 11 articles : les cinq 1^{ers} lisses ; les 3^e et 4^e du double plus longs que le 2^e ; les suivants presque égaux, un peu plus allongés ; le dernier terminé en pointe mousse. Corselet plus long que large, inégal, coupé obliquement en avant, droit à la base, conné et abaissé sur les côtés. Elytres modérément convexes, à stries ponctuées, arrondies à l'extrémité et non armées. Pattes simples, trapues ; les 2^e et 3^e articles des tarses profondément bilobés."

I have quoted this in full from the copy of the first volume of the 'Dictionnaire' belonging to the Zoological Society of London, which bears the date 1847 on the title-page (the first volume was, however, first published in 1841—see Sherborn & Palmer, "Dates of Charles d'Orbigny's Dictionnaire Universel d'Histoire Naturelle, 1839-1849," Ann. Mag. N. H. (7) iii. 1899, pp. 350-2), because there was a re-composition of the matter of the first volume at a later date.

From the above, it will be seen that *Alurnus ferrugineus* F. and *A. lucidiventris* Guérin were separated from the genus *Alurnus* and formed into a new genus which Chevrolat called *Anisodera*. As one of those species must be taken as the type of the genus *Anisodera*, I select Fabricius's species *ferrugineus* as being earlier than Guérin's. But both *ferrugineus* and *lucidiventris* are now included in a subgenus *Lissochila*, while *Anisodera excavata* Baly is made the type of *Anisodera* proper. There exist good structural differences between the subgenera which are fairly constant, and I consider them to be of generic importance. Owing to this fact and in view of the present note on the priority of Chevrolat's description of *Anisodera*, I propose to erect a new genus and sink *Lissochila* as a synonym of *Anisodera* as follows:—

- i. Labrum short, the transverse edge emarginate and covered with long and stiff hairs. The labrum lies in a lower plane than the clypeus. Upper side of the body shining. Elytra without pronounced ribs. *Anisoderopsis*, gen. n.

(Type *A. excavata* Baly.)

- ii. Labrum large, the transverse edge straight, sparsely covered with hairs. Labrum lies in the same plane as the clypeus, which is small and almost plain. Upper side of the body, as a rule, opaque. Elytra with pronounced ribs.

Anisodera Chevrolat.

(Type *A. ferruginea* Fab.)

Genus ONCHOCEPHALA Chev.

ONCHOCEPHALA QUADRILOBATA Guérin.

Onchocephala quadrilobata Guérin, Icon. Règn. Anim., Ins. 1844, p. 281; Weise, Deut. Ent. Zeit. 1897, p. 121 and 1905, p. 117; Gestro, Ann. Mus. Stor. Nat. Genova, 1899, p. 314, f. 1; Maulik, Rec. Ind. Mus. Calcutta, 1915, p. 372.

1 example.

Locality.—Ceylon, Oct. (*Fryer*).

Range. India, Andaman Islands.

Genus AGONIA Weise.

The genus *Agonia* is divided into two subgenera according to the number of costæ on each elytron, thus:—Elytra with three costæ and eight or more rows of punctures, *Agonia* s. str.; elytra with two costæ and six rows of punctures, *Agonella* Weise. In the present case there are four costæ and ten rows of punctures, I therefore take the following new species (*Agonia krishna*) as the type of a new subgenus which I name *Ekagonia*. The convexity of the eyes, the low costæ, the smooth parallel rows of punctures, the form of the body, all point to the conclusion that *Agonia krishna* has close affinity to the genus *Downisia* Baly. The species included in the subgenus *Agonella* have higher costæ, coarser punctures, and the body more dilated behind—characters which are strongly marked in the next genus *Gonophora*. For these reasons I place *Agonia krishna* at the beginning of the genus *Agonia*.

EKAGONIA, subgen. nov.

AGONIA (EKAGONIA) KRISHNA, sp. n. (Text-fig. 1.)

Elongate, parallel-sided, black, shining. First two joints of antennæ shining, the rest of the joints pubescent; interantennal space with a protuberance; eyes strongly convex. Prothorax parallel-sided, base bisinuate, moderately convex, disc shining, with a few scattered deep punctures, anterior surface transversely strigose with a few brownish hairs, base with a deep triangular fossa, each side with two shallower and rounded fossæ or depressions. Scutellum smooth, shining, with the apex rounded. Elytra with four costæ, first costa slightly elevated, ten rows of punctures, between the suture and the first costa only one row of punctures.

Length, from head to apex of elytra, 5.5 mm.

Described from one example.

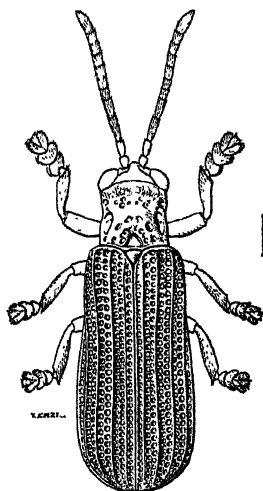
Locality.—Borneo (*Shelford*).

Type in the British Museum.

Head. The bases of the antennæ are well separated from the mouth-parts by the clypeus, which is strigose and depressed in the middle. Labrum covered with brownish hairs. Seen from above, the interantennal process is so prominent that it conceals

the bases of the antennæ from view. Antennæ, first two joints shining and rounded, third joint longest, after the third joint the antennæ are gradually thickened towards the apex. *Prothorax*: cylindrical, sides with bisinuate margins; front margin straight, brownish; posterior to the front margin the surface is transversely strigose and is sparsely covered with fine brownish hairs. Disc smooth, shining, with a few deep punctures. At the base in the middle is a very deep triangular fossa. On each side of the disc two depressions, the anterior shallower than the posterior; concavity of the depressions with deep punctures. *Scutellum* small, oval, smooth, shining. In this specimen there are about four small punctures near the margins. *Elytra* parallel sided, with four costæ on each elytron. The first costa is slightly

Text-figure 1.

*Agonia (Ekagonia) krishna*. $\times 8$.

elevated, the suture is as much elevated as the first costa if not more. The second costa is more elevated than the first, the third and fourth prominently elevated. All the costæ meet at the apex of the elytra. On each elytron there are altogether ten parallel rows of punctures disposed as follows:—Between the suture and first costa one row; between first and second costæ two rows; between second and third costæ two rows; between third and fourth costæ two rows; between fourth and lateral margin three rows. *Underside* smooth, shining, sparsely covered with brownish hairs; mentum, coxæ, margins of the abdominal sternites, tibiæ and tarsi with brownish tinge; fourth joint of tarsus not longer than the third, claws more or less hidden in the thick pubescence of the underside of the tarsus.

AGONIA CHERAPUNJIENSIS, sp. n. (Text-fig. 2.)

Elongate. Upperside subnitid, underside shining. Head, antennæ, underside, legs, a longitudinal middle line on the pronotum and the scutellum black, elytra and the rest of the body fulvous. Three costæ on each elytron. Three rows of punctures between the suture and the first costæ.

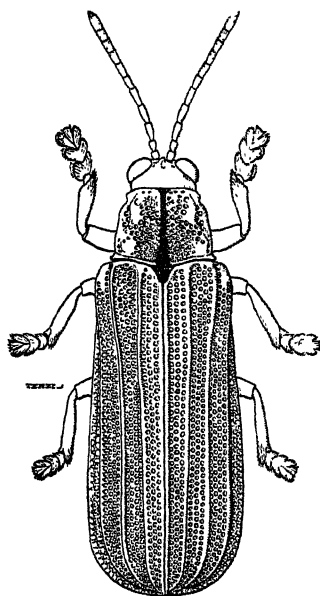
Length, from head to the apex of elytra, 14.5 mm.; antenna, 6 mm.; pronotum, 3 mm.

Locality.—Cherapunji, Assam, N.E. India (taken by Mrs. Somerset, 15. vii. 1907).

Described from one example.

Type in the British Museum.

Text-figure 2.



Agonia cherapunjiensis. $\times 4$.

Head. Antennæ moderately stout, basal joint short, second joint constricted at base, third joint longest, fourth joint shorter than third but longer than each of the following joints, fifth to seventh subequal, eighth to tenth equal but shorter than each of the preceding joints, eleventh joint bluntly pointed; surface of all the joints except the third hairy and with elongate punctures. Clypeus much broader than long, apex produced into a process which passes beyond the interantennal space. Labrum rufescent, edges bristly. Mandibles broad, black, very

powerful. Maxillary palpi 4-jointed, fulvous, hairy, fourth joint darker in colour and bluntly pointed. Labial palpi 3-jointed, fulvous, hairy, apex of second and third joints black, second joint dilated at the apex. *Prothoracæ* almost as long as broad, sides with a margin, a longitudinal broad black shining impunctate raised line in the middle, on each side of this line a raised impunctate surface. The surface of the pronotum is coarsely and broadly punctate, punctures becoming smaller near the base. *Scutellum* broader at base, apex rounded, black, impunctate. *Elytra*: length 11.5 mm.; slightly broadened at apex. Fulvous. Tricostate and punctate-striate. Between the suture and the first costa three rows of punctures throughout the whole length of the elytra; between the first and second costæ the rows of punctures vary; for a length of 2.5 mm. just beyond the base there are four rows of punctures; five punctures in a transverse line can be counted because the rows are confused; for a length of 2.5 mm. in the middle of the elytra three rows of punctures; beyond this the number of rows is increased to four; at the apex it is again three. Between the second and third costæ the rows of punctures are as follows:—From the smooth shining humeral callus up to the middle (for a length of 4.5 mm.) two and three rows of punctures; from the middle to the apex (except the extreme apex) four confused rows of punctures. Between the third costa and the lateral margin the rows of punctures may be stated as follows:—3, 2, 3, 4, 3.

Legs and underside. Black, smooth, shining.

AGONIA WALLACEI Baly.

Gonophora wallacei Baly, Cat. Hisp. 1858, p. 109; Waterhouse, Aid. Ident. Ins. ii. t. 153. f. 7; Gestro, Ann. Mus. Stor. Nat. Genova, 1885, p. 165 and 1897, p. 55.

3 examples.

Locality.—Borneo (*Shelford*, 20. x. 1901).

Range. Malacca, Sumatra.

Genus GONOPHORA Baly.

GONOPHORA HÆMORRHOIDALIS Weber, var. *UNDULATA* Weise.

Hispæ hæmorrhoidalis Weber; Maulik, Rec. Ind. Mus. Calcutta, xi. 1915, p. 373.

4 examples.

Locality.—Borneo (*Shelford*).

Range. India and the Indo-Malay Penin. Region.

GONOPHORA CHALYBEATA Baly.

Gonophora chalybeata Baly, Cat. Hisp. 1858, p. 115; Gestro, Ann. Mus. Stor. Nat. Genova, 1885, p. 168; Bull. Soc. Ital. 1902 (1903), p. 146.

1 example.

Locality.—Borneo (*Shelford*).

It has also been reported from Singapore.

GONOPHORA (LACHNISPA) MODIGLIANII Gestro.

Gonophora (Lachnispa) modiglianii Gest. Ann. Mus. Stor. Nat. Genova, 1892, p. 793 and 1897, p. 65.

1 example.

Locality.—Borneo (*Shelford*).

Dr. Modigliani first took this species at Egano Island.

Genus HISELLA Chap.

HISELLA ATRA Linné.

Hispella atra L.; Maulik, Rec. Ind. Mus. Calcutta, xi. 1915, p. 375.

1 example.

Locality.—Palestine (*Tristram*).

Range. Europe, North Africa, Asia Minor, Turkistan.

Genus DACTYLISPA Ws.

DACTYLISPA LONGICUSPIS Gest.

Hispa longicuspis Gestro, Ann. Mus. Stor. Nat. Genova, 1897, p. 108, fig.

1 example.

Locality.—Sarawak, Borneo (*Shelford*, 1897).

In the specimen before me the base of the elytra is not ferruginous. In other respects it agrees well with Dr. Gestro's description.

This species has a wide distribution, having been reported from Malacca, Sumatra, and Borneo.

DACTYLISPA BIPARTITA Guérin.

Hispa bipartita Guérin in Duperrey Voy. 'Coquille,' Zool. ii. 1830, p. 141; Gestro, Ann. Mus. Stor. Nat. Genova, 1897, p. 109, fig.; and Not. Leyd. Mus. xix. 1897, p. 175; Ritsema, Midden-Sumatra, iv. 1887, p. 180.

2 examples.

Locality.—Borneo (*Shelford*).

It has been reported from Sumatra, Malacca, Java, and Borneo.

DACTYLISPA MALAYANA (?) Gestro.

Dactylispa malayana Gestro, Bull. Soc. Ent. Ital. 1909 (1910), p. 139.

1 example.

Locality.—Malay Penin. (*Skeat Expedition*, 20. xi. 1900).

The species is identified from description.

DACTYLISPA FULVIPES (?) Motsch.

Hispa fulvipes Motschulsky, Schrenck's Reise Amur. ii. 1861, p. 238; Gestro, Bull. Soc. Ent. Ital. 1902, p. 56.

1 example.

Locality.—Ceylon (*Fryer*).

The species is identified from description.

DACTYLISPA TRIFIDA (?) Chap.

Hispida trifida (?) Chapuis, Ann. Soc. Ent. Belg. xx. 1877, p. 55; Gestro, Ann. Mus. Stor. Nat. Genova, 1885, p. 176 and 1897, p. 92.

1 example.

Locality.—Sarawak (*Shelford*, 1897).

This species has also a very wide distribution, having been reported from Malacca, Sumatra, and Java. The species is identified from description.

DACTYLISPA SOROR Weise.

Dactylispa soror Weise, Deut. Ent. Zeit. 1897, p. 134 and 1905, p. 120.

examples.

Locality.—Peradeniya, Ceylon (*Fryer*).

The occurrence of this species in Ceylon is recorded here for the first time. The other locality where it has been taken is the Nilgiri Hills.

DACTYLISPA SPINOSA (?) Weber.

Hispa spinosa Weber; Maulik, Rec. Ind. Mus. Calcutta, xi. 1915, p. 379.

1 example.

Locality.—Borneo (*Shelford*).

Range. Sumatra, Celebes.

The species is identified from description.

DACTYLISPA LEPTACANTHA Gestro.

Hispa leptacantha Gestro, Ann. Mus. Stor. Nat. Genova, 1897, p. 98; and Bull. Soc. Ent. Ital. 1904 (1905), p. 151.

5 examples.

Locality.—Sarawak (*Shelford*, 1897).

Range. Malacca, Sumatra, Borneo.

Genus *HISPA* L.*HISPA FABRICII* Guér.

Hispa fabricii Guérin in Duperrey Voy. 'Coquille,' Zool. ii. 1830, p. 140; and Icon. Règn. Anim., Ins. 1844, p. 268, t. 48. f. 3; Gestro, Ann. Mus. Stor. Nat. Genova, 1885, p. 174.

1 example.

Locality.—New Britain (*Willey*, l. iii. 1898).

Range. New Guinea, New Pomerania, New Mecklenburg.

Genus *PLATYPRIA* Guér.*PLATYPRIA ECHIDNA* Guér.

Platypria echidna Guérin, Rev. Zool. 1840, p. 139; Gestro.

Ann. Mus. Stor. Nat. Genova, 1890, p. 246, fig., and 1897, p. 112; Maulik, Rec. Ind. Mus. Calcutta, xi. 1915, p. 380.

1 example.

Locality.—Peradeniya, Ceylon (*Fryer*).

Range. India, Ceylon, Tonkin.

PLATYPRIA HYSTRIX F.

Hispa hystrix Fabricius, Suppl. Ent. Syst. 1798, p. 116; Maulik, Rec. Ind. Mus. Calcutta, xi. 1915, p. 381.

1 example.

Locality.—Peradeniya, Ceylon (*Fryer*).

Range. India, Ceylon.

CASSIDINÆ.

Genus HIMATIDIUM F.

HIMATIDIUM CAPENSE Herbst.

Cassida capensis Herbst, Natursyst. Käf. viii. 1799, p. 278, t. 133. f. 10.

Himatidium comptum Perty, Delect. Anim. Bras. 1830-34, p. 101, t. 20. f. 8; Guérin, Icon. Règn. Anim., Ins. 1844, p. 286.

Imatidium fasciatum Fabricius, Syst. El. i. 1801, p. 346; Illiger, Mag. Ins. i. 1802, p. 392.

Cassida fasciata Olivier, Ent. vi. 1808, p. 971; 97, t. 6. f. 100.

Himatidium fasciatum Boheman, Mon. Cassid. i. 1850, p. 65, t. 2. f. 13.

4 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Brazil, Bolivia, Ecuador, Peru.

Genus PRIOPTERA Hope.

PRIOPTERA WESTERMANNI Mannh.

Prioptera westermanni Mannerheim, Bull. Soc. Nat. Mosc. xvii. 1844, p. 864; Boheman, Mon. Cassid. i. 1850, p. 45.

1 example.

Locality.—Shan States, Burma, 23. iii. 1905.

Range. Assam, Tenasserim, Tonkin.

PRIOPTERA OCTOPUNCTATA F.

Cassida octopunctata Fabricius, Mant. Ins. 1787, p. 63; Ent. Syst. i. 1792, p. 296; Syst. El. i. 1801, p. 395; Liuné, Syst. Nat. ed. xiii, Gmel. 1787, i., iv. p. 1636; Olivier, Enc. méth. v. 1790, p. 382, and Ent. vi. 1808, p. 946; 97, t. 3. f. 38; Herbst, Natursyst. Käf. viii. 1799, p. 334.

Prioptera octopunctata Boheman, Mon. Cassid. i. 1850, p. 55.

Prioptera decempustulata, Boh. Mon. Cassid. i. 1850, p. 55.

Boheman distinguishes *decempustulata* from *octopunctata* thus:—"Statura et summa similitudo *P. 8-punctatæ*, sæpe non-nihil major, antennis totis flavo-testaceis, elytris subtiliter, vage punctulatis, pectore nigro, ab illa bene distincta." I have examined thirty-eight examples of *decempustulata* and *octopunctata* (Brit. Mus. Coll. & Camb. Univ. Coll.). In view of the material before me, I am in a position to state that the characters mentioned by Boheman to distinguish 10-*pustulata* from 8-*punctata* are untenable. These characters are merely individual variations. Moreover, the genus *Prioptera* is well known for the variability of its species. I therefore regard 10-*pustulata* as a synonym of 8-*punctata* F.

13 examples.

Locality.—Borneo (*Shelford*).

Range. Malacca, Sumatra, Java, Siam.

Genus EPISTICTIA Boh.

EPISTICTIA MATRONULA Boh.

Epistictia matronula Boheman, Mon. Cassid. i. 1850, p. 14; Weise, Deut. Ent. Zeit. 1901, p. 49.

1 example.

Locality.—Ceylon (*Fryer*).

This species has been reported only from Ceylon.

Genus OMA Spaeth.

In discussing the scope and limits of several genera of the Cassidinae (Archiv f. Naturg. lxxix. 1913, Abt. A. vi. p. 128), Dr. Spaeth erects the genus *Oma* for two species, viz., *monstrosa* Boh. and *denticula* Boh., which he separates from the genus *Desmonota* founded by Hope in 1839 (Ann. & Mag. Nat. Hist. (1) iii. 1839, p. 97). The differences in the characters of *Desmonota* and *Oma* may be stated as follows:—

Desmonota Hope.—The basal six joints of the antennæ are shining, and very sparsely covered with scattered hairs. The apical five joints are opaque and thickly covered with hair. The sixth joint is much shorter than the fifth and also the following joints.

Oma Spaeth.—The basal five joints of the antennæ are shining and very sparsely covered with scattered hairs. The six apical joints are opaque, and thickly covered with hairs. The sixth joint is longer and thicker than the fifth joint and about equal in length to the following joints.

Hope took Germar's species *Cassida platynota* as the type of *Desmonota* and drew up a description of the generic characters. In doing so he was in considerable doubt, as will appear from the following extract from his remarks on the genus:—"The

species of this division require a very accurate examination; none of my acquaintance accord altogether with the above generic characters; they require, therefore, further division; the typical insect is from the Brazils." Boheman, the next writer on the genus who described *monstrosa* and *denticula* under *Desmonota* (Mon. Cassid. i. 1850, pp. 144 & 141), evidently did not examine the specimens carefully or he would have been struck with the differences in the structure of the antennæ.

OMA DENTICULA Boh., var. KRISHNA, n.

The specimen before me agrees well with *denticula*, but the colour of the dorsal side is dark. As I cannot find any structural difference, I make this specimen the type of the new variety *krishna*.

Desmonota variolosa F., which is green in colour, has a similar dark variety. The occurrence of a dark variety in these allied genera is therefore not uncommon.

Locality.—South America, 25. i. 94.

It has been reported from Paraguay, Bolivia.

Type of variety in the British Museum.

Genus PRENEA Spaeth.

PRENEA STRIGATA Panz.

Cassida strigata Panzer in Voet's Beschreib. u. Abb. hartsch. Ins. 1798, p. 81, t. 42. f. 10.

Dolichotoma strigata Boheman, Mon. Cassid. i. 1850, p. 202.

Cassida similis Panzer, l. c. p. 81, t. 42. f. 11 (♀).

8 examples.

Locality.—Amazons (Goodman, 1879).

Range. Amazons, Ecuador.

Genus OXYNODERA Hope.

OXYNODERA COLLICULUS Boh.

Dolichotoma colliculus Boheman, Mon. Cassid. i. 1850, p. 189.

1 example.

Locality.—Amazons (Goodman, 1879).

It has been reported from Para.

Genus CANISTRA Er.

CANISTRA IRRORATA Guérin.

Oxytoma irrorata Guérin, Icon. Règne Anim., Ins. 1844, p. 289.

Canistra irrorata Boheman, Mon. Cassid. i. 1850, p. 168, t. 3. f. c.

2 examples.

Locality.—Amazons (Goodman, 1879).

Range. Brazil, Misiones, Bolivia, Paraguay.

Genus PSEUDOMESOMPHALIA Spaeth.

PSEUDOMESOMPHALIA CHALYBÆA Germ.

Cassida chalybæa Germar, Ins. Spec. Nov. 1824, p. 532.

Mesomphalia chalybæa Boheman, Mon. Cassid. i. 1850, p. 248.

1 example.

Locality.—Brazil.

Range. Brazil, Paraguay.

PSEUDOMESOMPHALIA DECENGUTTATA Sturm.

Cassida decenguttata Sturm, in Thon, Abbild. ausl. Ins. Käf. 1826–28, p. 2, t. 1. f. 3.

Mesomphalia decenguttata Boheman, Mon. Cassid. i. 1850, p. 321.

2 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Columbia, Equatorial Brazil.

PSEUDOMESOMPHALIA DISCOIDES Linné.

Cassida discoides Linné, Syst. Nat. ed. 10, 1758, p. 364; ed. 12, 1767, i., ii. p. 578; ed. 13, Gmel. 1787, i., iv. p. 1642.

3 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Equatorial Brazil, Peru, Columbia, Venezuela, Ecuador.

This has a very wide distribution. Since the time of Linné many writers have written about it, and it has received many names. For a list of the literature and the synonyms I refer the reader to the Catalogue of Cassidineæ by Dr. Spaeth (Berlin, 1914).

Genus NEOMPHALIA Spaeth.

NEOMPHALIA VULNERATA Boheman.

Mesomphalia vulnerata Boheman, Mon. Cassid. i. 1850, p. 249.

ab. *subpustulata* Boh. Mon. Cassid. i. 1850, p. 250.

1 example.

Locality.—Brazil.

NEOMPHALIA ADSPERSA Boheman.

Mesomphalia adpersa Boheman, Mon. Cassid. i. 1850, p. 355.

2 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Para, Brazil.

Genus PÆCILASPIS Hope.

PÆCILASPIS PANTHERINA Klug.

Cassida pantherina Klug, Preisverz. 1829, p. 7.

Pæcilaspis pantherina Boheman, Mon. Cassid. i. 1850, p. 413.

a b. *duodecimmaculata* Boh. l. c. p. 414.

5 examples.

Locality.—Pilcomayo (*J. Graham Kerr*).

Range. Brazil.

PÆCILASPIS DECEMPUSTULATA Boheman.

Pæcilaspis decempustulata Boheman, Mon. Cassid. i. 1850, p. 416.

1 example.

Locality.—S. America, 25. i. 94.

Boheman records it from Tucuman and Rio de la Plata.

PÆCILASPIS NERVOSA F.

Cassida nervosa Fabricius, Syst. El. i. 1801, p. 405; Illig. Mag. Ins. v. 1806, p. 228.

Pæcilaspis nervosa Boheman, Mon. Cassid. i. 1850, p. 386.

15 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Brazil, Paraguay.

Genus *ANACASSIS* Spaeth.

ANACASSIS CRIBRUM Klug.

Cassida cribrum Klug, Preisverz. 1829, p. 8.

Mesomphalia cribrum Boheman, Mon. Cassid. i. 1850, p. 356.

2 examples.

Locality.—Brazil.

Genus *SELENIS* Hope.

SELENIS SPINIFEX Linné.

Cassida spinifex Linné, Amœn. Acad. vi. 1763, p. 392; Syst. Nat. ed. 12, 1767, i., ii. p. 576; ed. 13, Gmel. 1787, i., iv. p. 1638.

3 examples.

Locality.—South America, 25. i. 94.

This is a very common insect. Many writers have written about it. I refer the reader to Spaeth's Catalogue, p. 52.

Boheman, Mon. Cassid. ii. p. 99, distinguishes *S. nebulosa* thus:—" *S. spinifex* minus lata, magis convexa, prothoracis et humerorum structura, nec non elytris apice sub-rotundatis, ab illa abunde distincta." Having examined 28 examples of *nebulosa* and *spinifex* in the collection of the British Museum, I am of opinion that they must be regarded as the same species and that characters mentioned by Boheman cannot distinguish them.

Genus *ECHOMA* Spaeth.

ECHOMA NORMALIS Germar.

Cassida normalis Germar, Ins. Spec. Nov. 1824, p. 538.

Omoplata normalis Boheman, Mon. Cassid. ii. 1854, p. 104.

Cassida suturalis Olivier, Enc. méth. v. 1790, p. 385; Ent. vi. 1808, p. 942; 97, t. 4. f. 95 (nec F.).

2 examples.

These are without locality-labels, but it is a well-known Brazilian species.

Genus OMASPIDES Boh.

OMASPIDES CLATHRATA L. (var. *a*).

1 example.

Locality.—Amazons (Goodman, 1879).

This is a common insect. It has also been reported from Dutch Guiana and Cayenne.

Genus CHELYMORPHA Boh.

CHELYMORPHA MARGINATA L.

2 examples.

Locality.—Amazons (Goodman, 1879).

Range. Cayenne, Brazil.

CHELYMORPHA VARIOLOSA Oliv.

Cassida variolosa Olivier, Enc. méth. v. 1790, p. 385; Ent. vi. 1808, p. 958; 97, t. 2. f. 21; t. 3. f. 46.

1 example.

Locality.—Amazons (Goodman, 1879).

Range. Para, Cayenne.

Genus PHYSONOTA Boh.

PHYSONOTA ALUTACEA Boh., var. CYRTODES.

Physonota alutacea Boheman, Mon. Cassid. ii. 1854, p. 192; Champion, Biol. Centr.-Amer., Col. vi. (2) 1885-94 (1894), p. 166.

2 examples.

Locality.—Mexico (Gadow).

Range. Central America, Columbia, Venezuela, Mexico.

Genus BATONOTA Hope.

Hope erected the genus *Batonota* (spine-backed) in 1839. He did not draw up any synoptical table of the allied genera. The remarkable dorsal prolongation of the elytra into a double spine led him to found this genus. He took *bidens* F. as the type, but at the same time he included *Cassida truncata* of Fabricius, which has no spine, in *Batonota*. Later authors did not question this inclusion of *truncata* F.: thus at present the genus is composed of 42 species of heterogeneous insects which obviously fall into at least three genera. Out of the 42 species 34 are

represented in the British Museum Collection, and these I have examined. The genus *Batonota* may be divided as follows:—

A. Scutellum trapezoidal.

1. The elytra produced into a long dorsal double spine, the lateral sides of the elytra concave at the middle *Batonota* Hope.
- 1'. The elytra not produced into a long spine, dorsally gibbous, the lateral sides of the elytra convex or straight, more explanate *Akantaka* †, gen. nov.

- A'. Scutellum triangular. Insects small, ovate; elytra dorsally more or less gibbous, deeply punctate . . . *Trikona* ‡, gen. nov.

The species are distributed as follows:—

Genus BATONOTA.	Genus AKANTAKA.	Genus TRIKONA.
<i>bidens</i> F.	<i>funesta</i> Boh.	<i>turrifera</i> Boh.
<i>nigra</i> Boh.	<i>truncata</i> Fab.	<i>humeralis</i> Oliv.
<i>monoceros</i> Germ.	<i>peregrina</i> Boh.	<i>lerouxi</i> Boh.
<i>pugionata</i> Germ.	<i>godmani</i> Baly.	
<i>pugnax</i> Boh.	<i>viridisignata</i> Boh.	
<i>cornigera</i> Boh.	<i>exaltata</i> Fab.	
<i>mucronata</i> Boh.	<i>dejeani</i> Boh.	
<i>aurita</i> Boh.	<i>bivittipennis</i> Boh.	
<i>parallela</i> Blanch.	<i>rufoornata</i> Baly.	
<i>ensifera</i> Boh.	<i>kiesenwetteri</i> Boh.	
<i>spinosa</i> Boh.	<i>collaris</i> Baly.	
<i>apiculata</i> Boh.	<i>tenebrosa</i> Boh.	
<i>aculeata</i> Boh.	<i>distincta</i> Baly.	
<i>yucatanica</i> Champ.	<i>sexplagiata</i> Wgenr.	
<i>nodosa</i> Boh.	<i>biplagiata</i> Champ.	
* <i>rufomarginata</i> Wgenr.	<i>insidiosa</i> Boh.	
* <i>rugosa</i> Wgenr.	* <i>kunzei</i> Boh.	
* <i>minima</i> Wgenr.	* <i>marginivittata</i> Wgenr.	
* <i>bellicosa</i> Boh.	* <i>aneocincta</i> Spaeth.	
	* <i>fasciata</i> Wgenr.	

In the above list I have not seen the species marked with an asterisk, but I have placed them in their respective genera with the help of Wagners table (Mitt. Münch. Ent. Ver. v. 1881, p. 44). *Batonota nodosa* Boh. appears to be an intermediate form. The shape of the body is similar to some forms of *Akantaka*, but the double spine on the back (which is rather short) decides its position in *Batonota*.

AKANTAKA RUFOORNATA Baly, var. AMAZONENSIS, n.

1 example.

I have examined six specimens of the species including the type. They are all from Nicaragua. The present example is the Brazilian variety of this species. Var. *amazonensis* is (1) larger, (2) the lateral sides of the elytra are more convex at the

† *Akantaka* is a Sanskrit word meaning "without thorn."

‡ *Trikona* is a Sanskrit word meaning "triangular."

posterior angles, (3) the rufous spots on the explanate margin of the elytra are much smaller.

Locality.—Amazons (*Goodman*, 1879).

'Type' of variety in the British Museum.

Genus ASPIDOMORPHA Hope.

ASPIDOMORPHA MILIARIS F.

Cassida miliaris Fabricius, Syst. Ent. 1775, p. 91.

Aspidomorpha miliaris Boheman, Mon. Cassid. ii. 1854, p. 261; Weise, Deut. Ent. Zeit. 1896, p. 16; Spaeth, Ann. Mus. Nat. Hung. i. 1903, p. 138; Maulik, Rec. Ind. Mus. ix. 1913, p. 110.

3 examples.

Locality.—Malay Penin. (*Skeat Expedition*, 30. xi. 1900).

Range. Philippine Is., Sunda Is., New Guinea, India, Yunnan, Tonkin.

ASPIDOMORPHA TECTA Boh.

Aspidomorpha tecta Boheman, Mon. Cassid. ii. 1854, p. 276; Weise in Voeltzkow, Reise Ostafrika, Chrysomel. 1910, p. 451.

4 examples.

Locality.—S. Africa (*M. Wilman*).

ASPIDOMORPHA PUNCTUM F.

Cassida punctum Fabricius, Syst. El. i. 1801, p. 404.

Aspidomorpha punctum Boheman, Mon. Cassid. ii. 1854, p. 281; Spaeth, Ann. Mus. Nat. Hung. i. 1903, p. 151.

1 example.

Locality.—Matador.

Range. New Guinea, Papua Is., North Australia.

It is a variable species.

ASPIDOMORPHA INQUINATA Boh.

Aspidomorpha inquinata Boheman, Mon. Cassid. ii. 1854, p. 309.

1 example.

Locality.—New Britain (*A. Willey*).

Hitherto it has been recorded from the Andamans and Tenasserim only. This species probably has a very wide range.

ASPIDOMORPHA AUSTRALASIÆ Boisd.

Aspidomorpha australasiæ Boisd. Faune Ent. Océanie (Astrolabe), ii. 1835, p. 537; Boheman, Mon. Cassid. ii. 1854, p. 308; Spaeth, Ann. Mus. Nat. Hung. i. 1903, p. 147.

1 example.

Locality.—Solomon Islands (*Willey*).

Range. New Guinea.

ASPIDOMORPHA ASSIMILIS Boh.

Aspidomorpha assimilis Boheman, Mon. Cassid. ii. 1854, p. 314; Spaeth, Ann. Mus. Civ. Genova, xli. 1904, p. 75.

1 example.

Locality.—Malay Penin. (*Skeat Expedition*, 30. xi. 1900).

Range. Java, Sumatra.

ASPIDOMORPHA CINCTA F.

Cassida cincta Fabricius, Spec. Ins. i. 1781, p. 109; Mant. Ins. i. 1787, p. 63; Ent. Syst. i. 1792, p. 295; Syst. El. i. 1801, p. 392; Linné, Syst. Nat. ed. 13, Gmel. 1787, i., iv. p. 1637; Herbst, Natursyst. Käf. viii. 1799, p. 331; Klug, Erman's Reise, 1835, p. 47.

Aspidomorpha cincta Boheman, Mon. Cassid. ii. 1854, p. 251; Wollaston, Col. Hesp. 1867, p. 154.

3 examples.

Localities.—Zomba, Nyasaland (*Cameron*, 25. iv. 1900); British Central Africa, 6. vi. 1908; Durban (*F. Muir*, 1902).

ASPIDOMORPHA NATALENSIS Boh.

Aspidomorpha natalensis Boheman, Mon. Cassid. ii. 1854, p. 303.

1 example.

Locality.—Zomba (*Cameron*, 25. iv. 1900).

ASPIDOMORPHA QUINQUEFASCIATA F.

Cassida quinquefasciata Fabricius, Syst. El. i. 1801, p. 401; Klug, Erman's Reise, 1835, p. 47.

Aspidomorpha quinquefasciata Boheman, Mon. Cassid. ii. 1854, p. 250.

1 example.

Locality.—Nyasaland, 6. vi. 1908.

Range. Central and West Africa, Réunion.

There is very little difference between *A. quinque-fasciata* F. and *A. ludibunda* Boh. I am inclined to think that they are the same species, particularly in view of the fact that the species of *Aspidomorpha* are extremely variable.

ASPIDOMORPHA AMABILIS Boh.

Aspidomorpha amabilis Boheman, Mon. Cassid. ii. 1854, p. 315; Weise, Deut. Ent. Zeit. 1897, p. 104.

Cassida micans Ol. Ent. vi. 1808, p. 960; 97, t. 5. f. 83 (nec F.).

Locality.—Java.

Range. India, Burma, Java, Sumatra, Ceylon.

ASPIDOMORPHA FURCATA Thunb.

Cassida furcata Thunberg, Nov. Ins. Spec. v. 1789, p. 87, t. 5. f. 96; Herbst, Natursyst. Käf. viii. 1799, p. 265, t. 132. f. 7.

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Cassida dorsata Ol. Enc. méth. v. 1790, p. 386; Ent. vi. 1808, p. 961; 97, t. 3. f. 45 (nec F.).

Cassida micans Fabricius, Syst. El. i. 1801, p. 398.

Aspidomorpha micans, Boh. Mon. Cassid. ii. 1854, p. 313.

1 example.

Locality.—Formosa (*ex coll. G. R. Crotch*).

Range. South China, India, Sunda Is.

ASPIDOMORPHA DULCICULA Boh.

Aspidomorpha dulcicula Boheman, Mon. Cassid. iv. 1862, p. 278; Spaeth, Sarawak Mus. Journ. i. 1912, p. 117; Maulik, Rec. Ind. Mus. ix. 1913, p. 112.

4 examples.

Locality.—Borneo (*Shelford*).

Range. Sumatra, Borneo.

ASPIDOMORPHA ST. CRUCIS F.

Cassida st. crucis Fabricius, Ent. Syst. iv. 1792, App. p. 446; Syst. El. i. 1801, p. 401.

Aspidomorpha st. crucis Boheman, Mon. Cassid. ii. 1854, p. 287, t. 6. f. B; Weise, Deut. Ent. Zeit. 1897, p. 102; Maulik, Rec. Ind. Mus. ix. 1913, p. 111.

5 examples.

Locality.—Java (*F. Muir*), Malay Penin. (*Skeat Expedition*, 30. xi. 1900).

Genus CONCHYLOCTENIA Spaeth.

In his recent Catalogue of the Cassidinae (Berlin, 1914) Dr. Spaeth has entirely omitted Boheman's species *Cassida nigrovittata* (Boh. Mon. Cassid. ii. 1854, p. 341). There are two examples, including the type, in the British Museum which Boheman records from Calcutta. I have seen a third example in Mr. Andrewes' collection which is from Chota Nagpur, India. The examination of these specimens reveals the fact that they cannot belong to the genus *Cassida*. But they agree well with the characters of *Conchyloctenia* as defined by Spaeth (Ann. Soc. Ent. Belg. 1902, p. 449). In the form of the body the species resembles the *tigrina* group; the tibiae are also sulcate on the external side; *nigrovittata*, therefore, must come under *Conchyloctenia*. It is interesting to note that all the species recorded under *Conchyloctenia* are found in Africa. This species therefore extends the distribution of the genus to the Oriental region.

CONCHYLOCTENIA TIGRINA Ol.

Cassida tigrina Olivier, Ent. vi. 1808, p. 957; 97, t. 5. f. 78; Boheman, Mon. Cassid. ii. 1854, p. 336.

2 examples.

Locality.—S. Africa (*M. Wilman*).

Genus HYBOSINOTA Spaeth.

HYBOSINOTA TURRIGERA Boh.

Cassida turrigera Boheman, Mon. Cassid. iv. 1862, p. 283.

Hybosinota turrigera Spaeth in Sjöstedt, Zool. Exped. Kili-
mandj. I. 1910, Abt. 7, p. 283.

Asphalisia tuta Weise, Arch. f. Naturg. lxx. 1904, i. p. 172.

1 example.

Locality.—Lourenço Marques (*F. Muir*, 10. viii. 1900).

Range. Zanzibar, Bechuanaland.

Genus LACCOPTERA Boh.

LACCOPTERA QUADRIMACULATA Thunb.

Cassida quadrimaculata Thunberg, Nov. Ins. Spec. v. 1789,
p. 86, t. 5. f. 94.

2 examples.

Locality.—Formosa (*ex coll. G. R. Crotch*).

Range. South China, India, Andaman Is.

Genus SILANA Spaeth.

SILANA FARINOSA Boh.

Cassida farinosa Boheman, Cat. Col. Ins. Brit. Mus. ix. 1856,
p. 146; and Mon. Cassid. iv. 1862, p. 350.

3 examples.

Locality.—Maha Illupalama, Ceylon (*J. C. F. Fryer*, iii. 1912).

This species has been reported from Ceylon only.

Genus CASSIDA L.

CASSIDA DECIPIENS Spaeth.

Cassida decipiens Spaeth, Deutsche Ent. Zeitschr. 1906,
p. 389.

1 example.

Locality.—Zomba (*Cameron*, 25. iv. 1900).

Spaeth reports it from Mashonaland.

Genus CHIRIDA Chap.

CHIRIDA CRUCIATA L.

Coptocycla cruciata Boh. Mon. Cassid. iii. 1855, p. 396.

Chirida cruciata Chapuis, Gen. Col. xi. 1875, p. 405.

1 example.

Locality.—Amazons (*Goodman*, 1879).

Range. Argentina, Brazil.

CHIRIDA SCALARIS Weber.

Cassida scalaris Weber, Observ. Ent. i. 1801, p. 51; Fabricius, Syst. El. i. 1801, p. 391; Olivier, Ent. vi. 1808, p. 967; 97, t. 6. f. 94.

Coptocyclus scalaris Boheman, Mon. Cassid. iii. 1855, p. 124.

Metrioria scalaris Weise, Deutsche Ent. Zeitschr. 1897, p. 107.

2 examples.

Locality.—Malay Penin. (*Skeat Expedition*, 30, xi. 1899).

Range. India and Indo-Malay region.

Genus THLASPIDA Weise.

THLASPIDA FORMOSÆ Spaeth.

Thlaspidia formosæ Spaeth, Ann. Mus. Nat. Hung. xi. 1913, p. 46; and Suppl. Ent. iii. 1914, p. 16.

1 example.

Locality.—Formosa (*ex coll. G. R. Crotch*).

Genus THLASPIDOSOMA Spaeth.

THLASPIDOSOMA DOHRNI, Spaeth.

Thlaspidosoma dohrni Spaeth, Stett. Ent. Zeit. lxii. 1901, p. 5; and Sarawak Mus. Journ. i. 1912, p. 119.

4 examples.

Locality.—Borneo (*Shelford*, 20, x. 1901).

Range. Sumatra.

Genus THLASPIDOMORPHA Spaeth.

THLASPIDOMORPHA BALYI Boh.

Coptocyclus balyi Boheman, Mon. Cassid. iii. 1855, p. 403.

1 example.

Locality.—Ceylon (*H. H. W. Pearson*).

Genus RHOCOCASSIS Spaeth.

RHOCOCASSIS FLAVOPLAGIATA Baly.

Coptocyclus flavoplagiatus Baly, Journ. Ent. ii. 1863, p. 102.

Metrioria flavoplagiata Weise, Deutsche Ent. Zeitschr. 1905, p. 125.

8 examples.

Locality.—Borneo (*Shelford*).

Range. Sumatra, Siam.

Genus COPTOCYCLA Boh.

COPTOCYCLA PLACIDA (?) Boh.

Coptocyclus placida Boheman, Mon. Cassid. iii. 1855, p. 415.

1 example.

Locality.—Amazons (*Goodman*, 1897).

Identified from description. It has also been reported from Cayenne, Guiana.

Genus *METRIONA* Weise.

METRIONA JUDAICA F.

Coptocyclus judaica Boheman, Mon. Cassid. iii. 1855, p. 293;
Champion, Biol. Centr.-Amer., Col. vi. (2) 1885-94, p. 209.

3 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. S. America, Panama.

METRIONA CIRCUMDATA Herbst.

Coptocyclus circumdata Boheman, Mon. Cassid. iii. 1855, p. 279.
Metriona circumdata Spaeth, Ann. Mus. Nat. Hung. i. 1903,
p. 128; Maulik, Rec. Ind. Mus. Calcutta, ix. 1913, p. 114.

1 example.

Locality.—New Britain (*A. Willey*, l. iii. 1898).

Range. India, Indo-China, Philippine Is., Celebes.

Genus *CHARIDOTIS* Boh.

CHARIDOTIS ABRUPTA Boh.

Charidotis abrupta Boheman, Mon. Cassid. iii. 1855, p. 11,
t. 7. f. B.

15 examples.

Locality.—Amazons (*Goodman*, 1879).

Range. Brazil, Venezuela, Cayenne, Guiana.

Genus *CTENOCHIRA* Chap.

CTENOCHIRA GEMINA Boh.

Coptocyclus gemina Boheman, Mon. Cassid. iii. 1855, p. 455.

1 example.

Locality.—Amazons (*Goodman*, 1879).

It has also been reported from Para.

CTENOCHIRA PLECTA Er.

Cassida plecta Erichson, Arch. f. Naturg. xiii. 1847, p. 154.

• *Coptocyclus plecta* Boheman, Mon. Cassid. iii. 1855, p. 505.

1 example.

Locality.—Amazons (*Goodman*, 1879).

It has also been reported from Peru.

29. Notes on the Wasps of the Genus *Pison*, and some allied Genera. By ROWLAND E. TURNER, F.Z.S., F.E.S.

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Key to the Genera most nearly allied to Pison.

- Mandibles excised on the outer margin *Pisonopsis* Fox.
Mandibles not excised... .. 2.
- Abdomen with a long petiole; mesopleurae coarsely longi-
tudinally striated *Aulacophilus* Sm.
Abdomen without a long petiole; mesopleurae not striated... *Pison* Jur.

The petiole in *Aulacophilus* is formed by the first sternite, distinguishing the genus clearly from those species of *Pison* in which the abdomen is subpetiolate through the narrowing of the first tergite to the base.

Genus AULACOPHILUS Sm.

Key to the Species of Aulacophilus.

- First recurrent nervure received distinctly before the apex of the first cubital; the slender petiole of the first segment, as far as the apex of the dorsal sulcus, longer than the hind trochanter and femur combined. *A. eumenoides* Dücke.
First recurrent nervure interstitial with the first transverse cubital nervure; the slender petiole of the first segment as far as the apex of the dorsal sulcus shorter than the hind trochanter and femur combined ... 2.
- Petiole to the end of the sulcus no longer than the hind femur; posterior ocelli distinctly further from the eyes than from each other; three basal joints of antennae ferruginous *A. vespeoides* Sm.
Petiole to the end of the sulcus longer than the hind femur; posterior ocelli equidistant from the eyes and from each other; antennae wholly black *A. jansonii* Tarn.

1. AULACOPHILUS EUMENOIDES Dücke.

Aulacophilus eumenoides Dücke, Zeitschr. Hym. Dipt. iv. p. 97 (1904), ♀.

This is at once distinguished from the two other species by the longer and more slender petiole, the slender portion of which

is distinctly longer than the posterior trochanter and femur combined; the second segment is gradually narrowed at the base as in *jansoni*, not broad at the junction with the first segment as in *vespoides*; the posterior ocelli are as far from each other as from the eyes, which are nearer to each other both on the vertex and the clypeus than in the two other species.

Hab. Obidos, Amazon (*Dücke*), November.

2. AULACOPHILUS VESPOIDES Sm.

Aulacophilus vespoides Sm. Trans. Ent. Soc. London, p. 305 (1869), ♀.

The petiole is more abruptly and strongly swollen at the apex than in either of the other species, the linear portion shorter, and the second segment very much broader at the base. The median segment is shorter than in *jansoni*, and the eyes further apart on the vertex; the colour of the legs and antennæ is also different.

Hab. Brazil (*Swainson*).

3. AULACOPHILUS JANSONI, sp. n.

♀. Nigra; opaca; segmento primo petiolo, calcariisque ferrugineis; alis subhyalinis; costa late fusco-hyalina, venis ferrugineis.

Long. 10 mm.

♀. Head, thorax, and median segment very finely and closely punctured, the frontal sulcus distinct, but very delicate; posterior ocelli as far from the eyes as from each other, the eyes about half as far again from each other on the clypeus as on the vertex. Antennæ short, much thickened towards the apex; second joint of the flagellum nearly as long as the first and third combined. Mesopleuræ very coarsely and closely horizontally striated, the area immediately below the tegulæ much more finely striated. Dorsal surface of the median segment about half as long again as the scutellum and postscutellum combined, the median sulcus distinct, the sides of the segment almost smooth, not irregularly obliquely striated on the upper part as in *vespoides*; the apical slope obscurely transversely striated, with a deep median sulcus. Petiole of the first abdominal segment a little longer than the hind femur; the swollen apical portion about twice as long as its apical breadth, much more slender and elongate than in *vespoides*; second segment gradually narrowed to the base; the third, fourth, and fifth segments with a narrow, dull brown, apical band. Second abscissa of the radius fully as long as the distance between the recurrent nervures on the cubitus; first recurrent nervure interstitial with the first transverse cubital nervure; transverse median nervure interstitial with the basal nervure.

Hab. Chontales, Nicaragua (*Janson*).

Differs from *vespoides* as noticed under that species in the key.

Genus PISON Jur.

Alyson Spinola, Ins. Ligur. ii. 4, p. 253 (1808) (nec Jurine).

Pison (Jurine) Spinola, Ins. Ligur. ii. 4, p. 255 (1808).

Tachybulus Latr. Gen. Crust. et Ins. iv. p. 75 (1809).

Nephridia Brullé, Ann. Soc. Ent. France, ii. p. 408 (1833).

Pisonitus Shuck. Trans. Ent. Soc. London, ii. p. 79 (1837).

Pisonoides Sm. Journ. Proc. Linn. Soc., Zool. ii. p. 104 (1857) (subgenus).

Parapison Sm. Trans. Ent. Soc. London, p. 298 (1869) (= *Pisonoides*).

Pseudonysson Rad. Horæ Soc. Ent. Ross. xii. p. 104 (1876).

Paraceramius Rad. Horæ Soc. Ent. Ross. xxi. p. 432 (1887) (= *Pisonoides*).

Taranga W. F. Kirby, Trans. Ent. Soc. London, p. 201 (1884).

Pisum Schulz, Spolia Hymen. p. 212 (1906).

The genus is very widely distributed, being found in almost all tropical and warm temperate countries, though it does not extend into the northern portions of the temperate zone. But the number of species in the different portions of its range is most uneven: out of one hundred and nine species catalogued fifty are from Australia, seventeen from the Austro-Malayan and various insular regions, thirteen from the Oriental, nine from the Palæarctic, nine from the Ethiopian, and eleven from the American regions. In my opinion, this distribution points to the genus being in a declining state, the majority of the species being from Australia or from island areas where the competition is likely to be less keen: the number of species on the large continental areas is not great, nor are individuals particularly numerous. Such of the species as have been observed build mud nests in holes in wood, key-holes, or similar situations, stocking their nests with small spiders, which are paralysed by stinging. Owing to these habits the species are easily transported on ships, giving rise to a considerable extension of range in several species, such as *P. spinolæ* and *P. argentatus*.

The genus has been divided into subgenera according to the neururation, but these subgenera are in no way natural; *Pisonoides* Sm., which must replace the later and more generally used *Parapison* Sm., has the second cell absent, but the species are not all nearly related to each other, and I have seen specimens of *Pison* in which the second cubital cell is absent on one side and present, though of small size, on the other side. *Pisonitus* Shuck., which is distinguished by the reception of the second recurrent nervure close to the middle of the second cubital cell, is difficult to separate with any certainty owing to variation in the position of this nervure in some species of *Pison*, as in *P. xanthopus* Brullé. The size of the second cubital cell is subject to much variation in many species of *Pison* and cannot be relied on for specific distinctions.

The present paper is founded on the collection of the British Museum, which contains nearly all the described Australian species, to which I am able to give a key, but owing to numerous gaps in the collection from other regions, I cannot give a key to the whole genus, but only to the species from certain regions. The sexual differences are not usually great, consisting of a difference in the shape of the anterior margin of the clypeus, and usually in an increase in the distance between the eyes in the male. But several species, such as *insigne* Sickm., *regalis* Sm., *tuberculatus* Sm., and *iridipennis* Sm., have carinæ or tubercles on the ventral segments of the male, and *algiricum* Kohl and *fenestratus* Sm. show a dilatation of some of the joints of the flagellum in the male.

The species which I have not seen are indicated by an asterisk.

Key to the Ethiopian Species of Pison (including those from St. Helena, Mascarene, and Seychelles Islands).

- | | |
|---|--|
| 1. Two cubital cells (<i>Pisonoides</i>) | 2. |
| Three cubital cells, very rarely with only two on one side (<i>Pison</i>) | 3. |
| 2. Legs, except the coxæ, ferruginous; first recurrent nervure interstitial with the first transverse cubital nervure | [(Seychelles.)
<i>P. isolatum</i> Turn. |
| Tarsi and fore tibiæ testaceous, the rest of the legs almost entirely black; first recurrent nervure received before the apex of the first cubital cell | <i>P. testaceipes</i> Turn. |
| 3. Second recurrent nervure received close to the middle of the second cubital cell | <i>P. argentatus</i> Shuck.
[(Mauritius.) |
| Second recurrent nervure received near the apex of the second cubital cell or interstitial with the second transverse cubital nervure | 4. |
| 4. The whole dorsal surface of the median segment obliquely striated | 5. |
| Dorsal surface of the median segment at most with a few oblique striæ at the base | 6. |
| 5. Striæ of median segment strong; the male with the apical abdominal segments ferruginous red | <i>P. xanthopus</i> Brullé. |
| Striæ of median segment very close and delicate; abdomen entirely black | <i>P. denticeps</i> Cam. |
| 6. Sides of the median segment (<i>mesopleuræ</i>) strongly obliquely striated | <i>P. clypeatus</i> Cam. |
| Sides of the median segment punctured or smooth, at most with a few delicate striæ at the base | 7. |
| 7. Median segment smooth and shining, except in the median sulcus and on the posterior slope | [(Seychelles.)
<i>P. speculare</i> Turn. |
| Median segment more or less strongly punctured | 8. |
| 8. Sides of median segment delicately striated at the base | <i>P. transvaalensis</i> Cam. |
| Sides of median segment punctured | 9. |
| 9. Abdomen smooth and shining, with only microscopic punctures; median segment very coarsely rugosely punctured | [(St. Helena.)
<i>P. wollastoni</i> Turn. |
| Abdomen closely and distinctly punctured, more strongly on the basal than on the apical segments; median segment less coarsely punctured | 10. |
| 10. Second cubital cell minute, or even obsolete on one side | <i>P. inæquale</i> Turn. |
| Second cubital cell normal | 11. |

- | | |
|---|------------------------------|
| 11. Apical dorsal segments smooth | <i>P. montanus</i> Cam. |
| Apical dorsal segments closely and distinctly punctured | 12. |
| 12. Posterior ocelli as far, or further, from the eyes as from each other | <i>P. allonyum</i> Schulz. |
| Posterior ocelli nearer to the eyes than to each other. | <i>P. rhodesianum</i> Bisch. |

Key to the Species of Pison inhabiting British India.

- | | |
|---|------------------------------|
| 1. Two cubital cells (<i>Pisonoides</i>) | 2. |
| Three cubital cells (<i>Pison</i>) | 6. |
| 2. First abdominal segment petiolate, long and narrow, the apical breadth not more than one-third of that of the second segment | <i>P. obliterated</i> Sm. |
| First segment not petiolate or elongate, the apical breadth more than half of that of the second segment | 3. |
| 3. Legs, except the coxæ, entirely light ferruginous | <i>P. erythropus</i> Kohl. |
| Legs either wholly piceous or with the tibiae only ferruginous | 4. |
| 4. Legs wholly piceous | <i>P. agilis</i> Sm. |
| Tibiae almost entirely dull ferruginous | 5. |
| 5. Posterior slope of median segment finely striated on the apical half | <i>P. rothneyi</i> Cam. |
| Posterior slope of median segment finely punctured | <i>P. differens</i> Turn. |
| 6. Second recurrent nervure received before two-thirds from the base of the second cubital cell. | 7. |
| Second recurrent nervure received just before the apex of the second cubital cell, or interstitial with the second transverse cubital nervure | 8. |
| 7. Front minutely punctured; a well-defined transverse impressed line behind the posterior ocelli | <i>P. argentatus</i> Shuck. |
| Front coarsely punctured; no distinct impressed line behind the posterior ocelli | <i>P. rugosus</i> Sm. |
| 8. Pubescence of abdominal fasciæ golden; median segment coarsely longitudinally striated, the striæ not curved | <i>P. kohlii</i> Bingh. |
| Pubescence of abdominal segments whitish, if present; striæ of median segment curved or absent | 9. |
| 9. Median segment strongly obliquely striated, without punctures | <i>P. punctifrons</i> Shuck. |
| Median segment punctured, with or without a few curved striæ | 10. |
| 10. Median segment with a few curved striæ; wings hyaline | <i>P. orientale</i> Cam. |
| Median segment without striæ; wings infusate, the apical margin broadly darker | <i>P. fasciatus</i> Rad. |

Key to the Australian Species of Pison.

- | | |
|--|---------------------------------|
| 1. Two cubital cells (<i>Pisonoides</i>) | 2. |
| Three cubital cells (<i>Pison</i>) | 12. |
| 2. First abdominal segment elongate, strongly narrowed to the base | 3. |
| First abdominal segment not elongate | 4. |
| 3. Second cubital cell pointed on the radius | <i>P. icarioides</i> Turn. |
| Second abscissa of the radius at least half as long as the first transverse cubital nervure | <i>P. difficile</i> Turn. |
| 4. Abdomen almost entirely ferruginous | 5. |
| Abdomen black, the apical margins of the segments sometimes dull brown with golden pubescence | 6. |
| 5. Median segment slender, longer than the breadth in the middle; eyes as far apart on the vertex as on the clypeus | <i>P. pertinax</i> Turn. |
| Median segment not slender, shorter than the breadth in the middle; eyes further apart on the clypeus than on the vertex | <i>P. erythrogastrium</i> Rohw. |

- | | | |
|--|-----|---------------------------------|
| 6. Slender species; abdomen entirely black, without pubescence | 7. | |
| More robust species; apical margin of abdominal segments dull brown, clothed with dull fulvous pubescence | | <i>P. exclusum</i> Turn. |
| 7. Legs more or less ferruginous | 8. | |
| Legs black; tarsi rarely luteous | 9. | |
| 8. Antennæ, trochanters, and femora ferruginous; nervures testaceous | | <i>P. erythrocerus</i> Kohl. |
| Antennæ, trochanters, and femora black; nervures black | | <i>P. simulans</i> Turn. |
| 9. Cubital margin of the second cubital cell scarcely or not at all longer than the first transverse cubital nervure | 10. | |
| Cubital margin of the second cubital cell much longer than the first transverse cubital nervure ... | 11. | |
| 10. Tarsi luteous; wings strongly iridescent | | <i>P. aberrans</i> Turn. |
| Tarsi black; wings very feebly iridescent | | <i>P. tenebrosus</i> Turn. |
| 11. With a small triangular enclosed space at the base of the median segment; clypeus broadly rounded at apex | | <i>P. noctulum</i> Turn. |
| Without an enclosed space at the base of the median segment; clypeus produced on the middle of the apical margin | | <i>P. caliginosus</i> Turn. |
| 12. Thorax, abdomen, legs, and antennæ testaceous, head only black; second recurrent nervure received before the middle of the second cubital cell | | <i>P. melanocephalus</i> [Turn. |
| Thorax always black; second recurrent nervure received at or beyond the middle of the second cubital cell | 13. | |
| 13. Second recurrent nervure received at the middle of the second cubital cell; first recurrent received well before the apex of the first cubital cell .. | 14. | |
| Second recurrent nervure received either near the apex of the second cubital cell or close to the base of the third cubital cell, or interstitial with the second transverse cubital nervure | 17. | |
| 14. Abdomen and antennæ black | 15. | |
| Abdomen and antennæ more or less ferruginous ... | 16. | |
| 15. Entirely black; with a continuous impressed transverse line behind the posterior ocelli | | <i>P. ignavum</i> Turn. |
| Legs ferruginous, the impressed line behind the posterior ocelli interrupted | | <i>P. rufipes</i> Shuck. |
| 16. Pubescence of the clypeus and front golden; distance separating the eyes on the clypeus more than half as great again as that separating them on the vertex | | <i>P. virosus</i> Turn. |
| Pubescence of the clypeus and front whitish; distance separating the eyes on the clypeus much less than half as great again as that separating them on the vertex | | <i>P. ruficornis</i> Sm. |
| 17. Second ventral segment shining, almost or entirely impunctate | 18. | |
| Second ventral segment closely and more or less distinctly punctured | 21. | |
| 18. Third and fourth joints of the flagellum strongly dilated beneath | | <i>P. fenestratus</i> Sm., ♂. |
| Third and fourth joints of the flagellum not dilated. | 19. | |
| 19. Of slender build; entirely black; median segment finely and not very closely punctured | | <i>P. priscum</i> Turn. |
| Of robust build; median segment closely and coarsely punctured or punctured-striate | 20. | |
| 20. Dorsal segments 2-5 with a broad apical band of golden pubescence, and a testaceous brown chitinous band beneath the pubescence | | <i>P. festinus</i> Sm. |
| Dorsal segments 2-5 entirely black, with an apical band of whitish pubescence | | <i>P. fenestratus</i> Sm., ♀. |

21. Abdomen wholly ferruginous 22.
 Abdomen wholly or partially black 24.
 22. Of small size, less than 7 mm. in length 23.
 Of larger size, 11 mm. in length *P. pelletieri* Le Guillou.
 23. Posterior ocelli nearly twice as far from each other
 as from the eyes; head not very large, pubescence
 of front white and sparse *P. lutescens* Turn.
 Posterior ocelli nearly as far from the eyes as from
 each other; head massive, pubescence of front pale
 golden and close *P. dimidiatus* Sm.
 24. Median segment very distinctly obliquely striated ... 25.
 Median segment punctured, sometimes striolate-
 punctured at the base 28.
 25. Abdomen black, with more or less distinct bands of
 silver pubescence 26.
 Abdomen black, with bands of golden or fulvous
 pubescence 27.
 26. Mandibles and apex of clypeus black; mandibles not
 unusually broad; posterior ocelli separated from
 the eyes by a distance less than half as great as
 their own diameter *P. westwoodi* Shuck.
 Mandibles and apex of clypeus ferruginous; man-
 dibles short and very broad; posterior ocelli sepa-
 rated from the eyes by a distance equal to their
 own diameter *P. mandibulatum* Turn.
 27. Tibiæ and tarsi ferruginous, tegulæ testaceous;
 transverse median nervure received beyond the
 basal nervure *P. simillimus* Sm.
 Tibiæ, tarsi, and tegulæ black; transverse median
 nervure interstitial with the basal nervure ... *P. dives* Turn.
 28. Black, with white pubescence; the tegulæ sometimes
 brown, also sometimes the apex of the ventral
 segments 29.
 Partly ferruginous or brown; or if black then with
 golden pubescence on the abdominal fasciæ ... 36.
 29. Second ventral segment evenly, closely, and finely
 punctured 30.
 Second ventral segment much more sparsely and
 coarsely punctured in the middle than at the sides. 33.
 30. Median segment shining, the punctures microscopic;
 length 6 to 7 mm. *P. infumatum* Turn.
 Median segment opaque or subopaque, very dis-
 tinctly punctured or punctured-rugulose; length
 from 9 to 15 mm. 31.
 31. Second joint of the flagellum a little less than half
 as long again as the third; length from 12 to
 15 mm. 32.
 Second joint of the flagellum scarcely exceeding the
 length of the third; length from 9 to 12 mm. *P. strenuum* Turn.
 32. Posterior ocelli as far from the eyes as from each
 other, separated from the eyes by a distance ex-
 ceeding their own diameter *P. perplexus* Sm., ♂.
 Posterior ocelli nearer to the eyes than to each other,
 separated from the eyes by a distance less than
 their own diameter. *P. fuscipennis* Sm., ♀.
 33. Second joint of the flagellum distinctly longer than
 the third; abdominal segments not constricted;
 puncturation of the dorsal segments very minute
 or almost obsolete 34.
 Second and third joints of the flagellum subequal;
 abdominal segments rather strongly constricted;
 puncturation of the dorsal segments not very
 minute *P. punctulatum* Kohl.
 34. Puncturation of the mesonotum obsolete; posterior
 ocelli as near to the eyes as to each other, sepa-
 rated from the eyes by a distance not exceeding
 their own diameter *P. spinolæ* Shuck.

- Puncturation of the mesonotum not obsolete; posterior ocelli nearer to each other than to the eyes, separated from the eyes by a distance considerably exceeding their own diameter 35.
35. Mesonotum very finely punctured; second abscissa of the radius no longer than the petiole of the second cubital cell *P. congener* Turn.
- Mesonotum more strongly punctured; second abscissa of the radius half as long again as the petiole of the second cubital cell *P. scabrum* Turn.
36. Two basal segments of abdomen ferruginous *P. basalis* Sm.
- Second abdominal segment black; the apical margin sometimes brown 37.
37. Basal segment of abdomen black; the apical margin sometimes brown 38.
- Basal segment of abdomen ferruginous, with a little black at the base 48.
38. Tibiæ and tarsi black or piceous 39.
- Tibiæ and tarsi ferruginous 42.
39. Abdomen covered with golden pubescence, denser on the apical fasciæ than elsewhere; pubescence of the front golden; tibiæ and tarsi black *P. auriventre* Turn.
- Pubescence of the abdomen confined to the apical fasciæ; pubescence of the front silver; tibiæ and tarsi more or less piceous 40.
40. Abdominal fasciæ dull whitish or dull pale fulvous; second joint of flagellum no longer than the third. Abdominal fasciæ shining golden; second joint of the flagellum much longer than the third... .. 41.
41. Punctures of the median segment very close, mingled with very fine indistinct oblique striæ *P. vestitus* Sm.
- Punctures of the median segment sparser and not intermingled with striæ *P. marginatus* Sm.
42. Antennæ wholly black *P. separatus* Sm.
- Basal joints of the antennæ ferruginous..... 43.
43. Trochanters and femora wholly ferruginous; length 6 mm. 45.
- P. inconspicuum* Turn.
- Trochanters black, femora ferruginous at the apex only; length at least 8 mm. 44.
44. Posterior ocelli in the female separated from the eyes by a distance about equal to their own diameter, in the male by a distance equal to nearly twice their own diameter *P. tibialis* Sm.
- Posterior ocelli in the female separated from the eyes by a distance scarcely exceeding half of their own diameter, in the male by a distance about equal to their own diameter *P. fraterculus* Turn.
45. Second dorsal segment with a brown chitinous apical band, clothed with golden or whitish pubescence. 46.
- Second dorsal segment entirely black, without a chitinous or pubescent apical band. *P. pulchrum* Turn.
46. Median segment, especially at the apex, densely clothed with golden pubescence; first abdominal segment elongate, scarcely broader at the apex than the base of the median segment *P. aurifex* Sm.
- Median segment without dense pubescence, the pubescence, if any, not golden; first abdominal segment much broader at the apex than the base of the median segment, not elongate 47.
47. Pubescence of abdominal fasciæ golden; length of male over 9 mm. *P. meridionale* Turn.
- Pubescence of abdominal fasciæ whitish; length of male 7 mm. *P. decipiens* Sm.
48. Second dorsal segment with a broad chitinous ferruginous band at the apex, the band clothed with golden pubescence 49.
- Second dorsal segment entirely black, without golden pubescence 50.

49. Posterior ocelli separated from the eyes by a distance fully equal to their own diameter; second ventral segment black, broadly ferruginous at the apex ... *P. aureosericeum* Rohw.
 Posterior ocelli separated from the eyes by a distance distinctly less than their own diameter; second ventral segment wholly ferruginous *P. auratus* Shuck.
50. First dorsal segment with a black spot on each side near the middle; transverse median nervure received before the basal nervure... *P. exornatum* Turn.
 First dorsal segment not spotted with black; transverse median nervure received beyond the basal nervure... *P. exultans* Turn.

1. PISON (PISONOIDES) ICARIOIDES Turn.

Pison (Aulacophilus) icarioides Turn. Proc. Zool. Soc. London, p. 521 (1908), ♀.

The species is better placed in *Pisonoides* than in *Aulacophilus*, being without the long petiole and striated mesopleuræ characteristic of the latter. The first abdominal segment is, however, much more elongate than in other species of *Pisonoides*, except *difficile*, from which it is easily distinguished by the short and stout antennæ, and the different shape of the second cubital cell.

Hab. Cairns, Q. (*Dodd*); Mackay, Q. (*Turner*), January; Brisbane, Q. (*Hacker*), January.

2. PISON (PISONOIDES) DIFFICILE Turn.

Pison (Aulacophilus) difficile Turn. Proc. Zool. Soc. London, p. 520 (1908), ♀.

Hab. Cairns, Q. (*Turner*), January; Mackay, Q. (*Turner*).

This species and the last superficially resemble *Icaria socialistica* Sauss. and other closely related species of *Icaria*, which occur in the same district.

3. PISON (PISONOIDES) PERTINAX Turn.

Pison (Parapison) pertinax Turn. Proc. Zool. Soc. London, p. 517 (1908), ♀.

The abdomen is usually wholly ferruginous, but the third and fourth dorsal segments are sometimes more or less infuscated.

Hab. Cairns, Q. (*Turner*), July; Mackay, Q. (*Turner*), November to May; Brisbane, Q. (*Hacker*), May.

4. PISON (PARAPISON) ERYTHROGASTRUM Rohw.

Pison (Parapison) erythrogastrum Rohw. Proc. U.S. Nat. Mus. xlix. p. 247 (1915), ♀.

This is very near *pertinax*, but may be distinguished by the greater distance between the eyes on the clypeus, by the longer pronotum, and by the shorter and broader median segment. The sculpture of the median segment is also more distinct.

Hab. Duaringa, Q. Probably from the Barnard collection. Kalamunda, W.A. (*Turner*), February and March.

5. PISON (PISONOIDES) ERYTHROCERUS Kohl.

Parapison ruficornis Sm. Trans. Ent. Soc. London, p. 300 (1869), ♀ (nec Smith, 1856),

Pison erythrocerus Kohl, Verh. zool.-bot. Ges. Wien, xxxiv. p. 186 (1884), ♀.

Pison erythrocerum D. T. Cat. Hymen. viii. p. 711 (1897).

The clypeus of the male is armed with three short acute teeth on the middle of the apical margin.

Hab. Mackay, Q. (*Turner*), February to May; Kuranda, Q. (*Turner*), May and June.

6. PISON (PISONOIDES) SIMULANS Turn.

Pison (Parapison) simulans Turn. Ann. & Mag. Nat. Hist. (8) xv. p. 559 (1915), ♂.

This is very near *erythrocerus*, but in addition to colour-differences the sculpture of the median segment is more strongly developed, and there is only one tooth in the middle of the apical margin of the clypeus.

Hab. Eaglehawk Neck, S.E. Tasmania (*Turner*), March.

7. PISON (PISONOIDES) NOCTULUM Turn.

Pison (Parapison) noctulum Turn. Proc. Zool. Soc. London, p. 516 (1908), ♀.

The cubital margin of the second cubital cell is twice as long as the first transverse cubital nervure; the nervures are fuscous, the stigma ferruginous. The median segment is longer than in *caliginosum*, and there is a small triangular space at the base, the apex of the triangle meeting the median carina. The pronotum is longer than in *caliginosum* or *tenebrosus*.

Hab. Mackay, Q. (*Turner*), February; Kuranda, Q. (*Turner*), June.

8. PISON (PISONOIDES) CALIGINOSUM Turn.

Pison (Parapison) caliginosum Turn. Proc. Zool. Soc. London, p. 518 (1908), ♀.

The cubital margin of the second cubital cell is about half as long again as the first transverse cubital nervure, the latter curved, not straight as in *noctulum*; nervures and stigma black; median segment without a triangular space at the base.

Hab. Kuranda, Q. (*Turner*), February.

9. PISON (PISONOIDES) TENEBROSUM Turn.

Pison (Parapison) tenebrosus Turn. Proc. Zool. Soc. London, p. 518 (1908), ♀.

The second cubital cell is triangular, the cubital margin equal in length to the first transverse cubital nervure.

Hab. Mackay, Q. (*Turner*), January.

10. PISON (PISONOIDES) ABERRANS Turn.

Pison (Parapison) aberrans Turn. Proc. Zool. Soc. London, p. 519 (1908), ♂.

This little species differs from *tenebrosus* in the pale yellowish colour of the tarsi, in the deeper longitudinal depression on the dorsal surface of the median segment, and in the strongly iridescent wings. The cubital margin of the second cubital cell is very short, scarcely more than half as long as the first transverse cubital nervure.

Hab. Mackay, Q. (*Turner*), January.

11. PISON (PISONOIDES) EXCLUSUM Turn.

Pison (Parapison) exclusum Turn. Ann. & Mag. Nat. Hist. (8) xviii. p. 127 (1916), ♂.

Parapison frenchi Cam. MS., ♀.

This is a robust species, differing much from other Australian species of *Parapison*, and resembling *Pison vestitus* Sm., though differing constantly in the absence of the small, petiolate, second cubital cell. The female was taken in Victoria capturing spiders on orange-trees.

Hab. Brisbane, Q. (*Hacker*), November; Horsham, Victoria (*Davey*), July.

12. PISON MELANOCEPHALUM Turn.

Pison melanocephalum Turn. Proc. Zool. Soc. London, p. 515 (1908), ♀.

This very distinct little species cannot be confused with any other, owing to the remarkable colouring; but it is also distinguished by the very close approach of the eyes at the base of the clypeus, where they are separated by a distance only a little more than half as great as that separating them on the vertex, and by the very large facets of the eyes in front. The petiolate second cubital cell is very small, and the first recurrent nervure is received far before the apex of the first cubital cell, as in *Pisonoides pertinax* and *erythrocerus*, to which the relationship seems closer than to typical *Pison*. It is best regarded as a link between the *Pisonoides* and *Pisonitus* groups.

Hab. Cairns, Q. (*Turner*), February.

13. PISON IGNAVUM Turn.

Pison ignavum Turn. Proc. Zool. Soc. London, p. 511 (1908), ♀.

This belongs to Shuckard's subgenus *Pisonitus*, the second recurrent nervure being received at the middle of the second cubital cell. I look on it as the Australian subspecies of the wide-ranging *P. argentatum* Shuck., differing from the typical Mauritius form in the much stronger sculpture of the median segment.

Hab. Mackay, Q. (*Turner*), December to April; Kuranda, Q. (*Turner*), January to March; Ravawai, Fiji (*Veitch*), November and December.

14. *PISON RUFIPES* Shuck.

Pison (*Pisonitus*) *rufipes* Shuck. Trans. Ent. Soc. London, ii. p. 79 (1837), ♀.

This may be distinguished from other Australian species of the *Pisonitus* group by the black abdomen and red legs, *P. ignavum* being wholly black, and the other species of the group having the abdomen and antennæ more or less red.

Hab. Eaglehawk Neck, S.E. Tasmania (*Turner*), February; Mt. Wellington, Tasmania (*Turner*), January; Melbourne, Victoria (*French*); Yallingup, S.W. Australia (*Turner*), November; Kalamunda, W. Australia (*Turner*), March and April.

15. *PISON VIROSUM* Turn.

Pison virosum Turn. Proc. Zool. Soc. London, p. 513 (1908), ♀.

This is a larger and more robust species than *ruficornis*, and may also be distinguished by the greater distance between the eyes on the clypeus and by the golden pubescence of the clypeus and front. The abdomen is ferruginous, except at the extreme base.

Hab. Mackay, Q. (*Turner*), September to February.

16. *PISON RUFICORNIS* Sm.

Pison (*Pisonitus*) *ruficornis* Sm. Cat. Hym. B. M. iv. p. 315 (1856), ♀.

Pison ruficorne Turn. Proc. Zool. Soc. London, p. 514 (1908), ♀.

The type has the abdomen largely shaded with black, but in many specimens it is wholly ferruginous. In both this species and *virosum* there is a rather indistinct impressed transverse line behind the posterior ocelli, which seems to be characteristic of the *Pisonitus* group.

Hab. Macintyre River, Q. (type); Mackay, Q. (*Turner*), October to March; Kuranda, Q. (*Turner*), March to May; Victoria (*French*).

17. *PISON PRISCUM* Turn.

Pison insulare Sm. st. *priscum* Turn. Proc. Zool. Soc. London, p. 510 (1908), ♀.

The difference in the distance between the eyes on the vertex in *insularis* and *priscum* is quite distinct, though not very great; the sulcus on the median segment is much more distinct in *insularis*, and the second dorsal segment is more depressed at the base. The clypeus is also slightly different. Until a long series from different localities is available, it may be best to treat the two forms as distinct species. In *priscum* the second ventral segment is not as highly polished as in *festivus* and *fenestratus*, but there are no distinct punctures. The insect is entirely black, except on the apical margins of the ventral segments, which are brownish.

Hab. Mackay, Q. (*Turner*), November.

18. PISON FESTIVUS Sm.

Pison festivus Sm. Trans. Ent. Soc. London, p. 296 (1869), ♀.

The head is broad, the posterior ocelli are a little further from the eyes than from each other, the clypeus very broadly rounded at the apex. The median segment is obliquely striated, with punctures intermixed, the median carina is distinct, but not placed in a sulcus; the first dorsal segment is strongly depressed at the apex. Male unknown.

Hab. Swan River, W.A. (*Du Boulay*).

19. PISON FENESTRATUS Sm.

Pison nitidus Sm. Trans. Ent. Soc. London, p. 248 (1868), ♀ (nec Smith, 1858).

Pison fenestratus Sm. Trans. Ent. Soc. London, p. 291 (1869).

This species is allied to *festivus*, but is rather less robust, the colour of the abdominal fasciæ is different, and the median segment is closely and strongly punctured, not striate. The male has the third and fourth joints of the flagellum strongly dilated beneath.

Hab. Champion Bay, W.A. (*Du Boulay*); Yallingup, W.A. (*Turner*), January; Hermannsburg, Central Australia (*Hillier*).

20. PISON DIMIDIATUS Sm.

Pison dimidiatus Sm. Trans. Ent. Soc. London, p. 295 (1869), ♂.

The head is massive, the posterior ocelli being nearly as far from the eyes as from each other; the clypeus is produced into an acute point; the second abscissa of the radius is a little longer than the petiole of the second cubital cell; the transverse median nervure is interstitial with the basal, and the sulcus of the median segment is quite distinct, with the usual carina. Female unknown.

Hab. Champion Bay, W.A. (*Du Boulay*).

21. *PISON PELLETIERI Le Guillou.

Pison pelletieri Le Guillou, Ann. Soc. Entom. France, p. 320 (1841), ♀.

“Capite nigro, facie aureo-pubescente; antennis et mandibulis fulvis; mesothorace nigro; metathorace punctato-scabro, albo pubescente; abdomine et pedibus fulvis; alis translucidis. ♀. Long. 11 mm. *Hab.* Australie septentrionale.

Tête noire; yeux échancrés en dedans, toute la face est couverte d'un duvet doré. Antennes à mandibules fauves. Corselet noir. Métathorax pointillé en manière de chagrin, couvert d'un léger duvet blanchâtre; abdomen et pattes entièrement fauves. Ailes claires.”

22. *PISON LUFESCENS*, sp. n.

♀. Nigra; mandibulis, antennis, abdomine pedibusque rufo-ferrugineis; tegulis testaceis; alis hyalinis, venis fuscis.

Long. 4 mm.

♀. Clypeus short and broad, subtruncate at the apex, covered with delicate silver pubescence. Head very closely microscopically punctured, with an obscure frontal sulcus reaching the anterior ocellus. Eyes very little further apart on the clypeus than on the vertex; the posterior ocelli nearly twice as far from each other as from the eyes, and as far from each other as from the posterior margin of the head. Pronotum oblique; mesonotum and scutellum microscopically punctured. Median segment scarcely as long as the mesonotum, rounded posteriorly, finely punctured, granulate, the median sulcus almost obsolete, the median carina distinct; the posterior slope of the segment very finely transversely striolate, with a deep median sulcus. Abdomen minutely punctured; second segment scarcely depressed at the base, the apical margins of the segments in some lights showing fasciæ of very delicate silver pubescence. Second abscissa of the radius shorter than the petiole of the second cubital cell; recurrent nervures interstitial with the transverse cubital nervures; second cubital cell not quite as high as the length of its petiole; transverse median nervure interstitial with the basal nervure.

Hab. Mundaring Weir, W.A. (*Turner*), March 18, 1914.

This little species closely resembles a small *P. ruficornis*, but the neuration is different, also the sculpture of the median segment, and the antennæ are shorter and stouter.

23. *PISON WESTWOODI* Shuck.

Pison westwoodi Shuck. Trans. Ent. Soc. London, ii. p. 77 (1837), ♀.

? *Pison obliquus* Sm. Cat. Hym. B. M. iv. p. 316 (1856), ♀.

Shuckard states that the carina of the median segment is absent in this species, but this is not usually the case, a long series taken by me in Tasmania showing variation in this respect from a well-developed carina to the typical form as described by Shuckard. The species may be easily recognised by the striation of the whole dorsal surface of the median segment and the very close proximity of the posterior ocelli to the eyes. I think that *P. obliquus* Sm. is a synonym, but I have not seen the type. There is a short transverse carina at the base of the third ventral segment of the male, as in the closely allied *P. iridipennis* Sm.

Hab. Eaglehawk Neck, Tasmania (*Turner*), March; Mt. Wellington, Tasmania (*Turner*), January; Yallingup, W.A. (*Turner*), November; Kalamunda, W.A. (*Turner*), March; Mackay, Q. (*Turner*), Cairns, Q. (*Turner*), October to June.

24. *PISON MANDIBULATUM*, sp. n.

♀. Nigra; albo-pubescent; clypeo apice mandibulisque ferrugineis; alis hyalinis, apice leviter infuscatis, venis nigris; segmento mediano oblique striato.

♂. Feminæ similis; clypeo omnino nigro.

Long., ♀ 9 mm., ♂ 8 mm.

♀. Mandibles very broad and short, not narrowed at the apex; clypeus in both sexes produced in the middle, but much more distinctly so in the female than in the male. Eyes separated on the vertex by a distance about three times as great as the length of the second joint of the flagellum, on the clypeus by about four times the length of the same joint; posterior ocelli separated from the eyes by a distance fully equal to their own diameter, a little further from the posterior margin of the head than from each other. Antennæ not very stout, the second joint of the flagellum equal to the third, nearly twice as long as the first. Head and thorax very closely punctured; the frontal sulcus very indistinct, the clypeus and front as high as the emargination of the eyes clothed with silver pubescence. Median segment obliquely striated on the whole dorsal surface; the median sulcus almost obsolete; the median carina distinct, but not reaching the apex; the posterior slope transversely striated. Abdomen finely and closely punctured; the first segment moderately constricted at the apex, second ventral segment evenly and very distinctly punctured. The white pubescence on the abdomen is confined to the sides of the segments, and does not form apical bands. Calcaria black. Second abscissa of the radius shorter than the petiole of the second cubital cell; recurrent nervures interstitial with the transverse cubital nervures; transverse median nervure a little nearer to the base of the wing than the basal nervure.

Hab. Yallingup, S.W. Australia (*Turner*), November and December. 1 ♀ and 4 ♂ ♂.

Easily distinguished from other black species by the colour and breadth of the mandibles. It is remarkable that the clypeus is much more distinctly pointed in the female than in the male.

25. *PISON INFUMATUM* Turn.

Pison infumatum Turn. Proc. Zool. Soc. London, p. 510 (1908), ♀.

This little species may be recognised by the shining median segment, on which the punctures are microscopic.

Hab. Port Darwin (*Turner*), December.

26. *PISON PERPLEXUS* Sm.

Pison perplexus Sm. Cat. Hym. B. M. iv. p. 314 (1856), ♂.

This differs from *fuscipennis* as indicated on the key by the proportionate distance between the posterior ocelli and the eyes.

I am inclined to think that this difference may prove to be sexual, but do not think it would be justifiable to sink *fuscipennis* as a synonym until more material is available.

Hab. Victoria (*French*).

27. PISON FUSCIPENNIS Sm.

Pison fuscipennis Sm. Trans. Ent. Soc. London, p. 294 (1869), ♀.

This is distinguished from *spinolæ* and other related species by the even puncturation of the second ventral segment.

Hab. Champion Bay, W.A. (*Du Boulay*).

28. PISON STRENUUM, sp. n.

♀. Nigra; tegulis apice testaceis; segmentis dorsalibus 1-4 fascia apicali albo-pilosa; alis sordide hyalinis, apice leviter infuscatis, venis nigris.

Long., ♀ 11-12 mm., ♂ 9-10 mm.

♀. Clypeus closely punctured, twice as broad as long, rounded at the apex and produced in the middle into a blunt smooth process; clothed with sparse silver pubescence, which also extends as high as the base of the antennæ. Second joint of the flagellum scarcely longer than the third. Posterior ocelli about equidistant from each other and from the eyes, separated from the eyes by a distance about equal to their own diameter; the distance separating the eyes on the clypeus nearly twice as great as that separating them on the vertex. Head and thorax very closely and minutely punctured. Median segment very closely and minutely punctured, with extremely short oblique striae along the basal margin; the median sulcus distinct, without a carina, the surface of the posterior slope transversely striated, with a strong median sulcus. Dorsal surface of the abdomen microscopically punctured, the segments not constricted; second ventral segment very closely, evenly, and finely punctured. Second abscissa of the radius rather variable in length, in the type as long as the petiole of the second cubital cell, but usually shorter; recurrent nervures interstitial with the transverse cubital nervures, the first sometimes received just beyond the base by the second cubital cell; transverse median nervure interstitial with the basal.

Hab. Yallingup, S.W. Australia (*Turner*), October to December; South Perth, W.A. (*H. M. Giles*), January.

The male has the clypeus produced into a spine, the second joint of the flagellum distinctly longer than the third, and the eyes on the vertex further apart, only one and a half times as far apart on the clypeus as on the vertex.

The species is smaller than *perplexus* or *fuscipennis*, and has the second joint of the flagellum much shorter; the clypeus is much more produced at the apex in both sexes, and there is no fascia of white pubescence on the fifth dorsal segment, which fascia is present in *fuscipennis*.

29. PISON SPINOLÆ Shuck.

Pison spinolæ Shuck. Trans. Ent. Soc. London, ii. p. 76 (1837), ♀.

Pison australis Sauss. Mém. Soc. Phys. & Hist. Nat. Genève, xiv. ii. (1853), ♀.

Pison tasmanicus Sm. Cat. Hym. B. M. iv. p. 316 (1856), ♂.

Taranga dubia W. F. Kirby, Trans. Ent. Soc. London, p. 201 (1883), ♂.

Pison pruinosus Cam. Mem. Manchester Lit. & Phil. Soc. xlii. p. 44 (1897), ♀.

This species may be distinguished by the smooth opaque mesonotum. The second cubital cell varies much in size, being sometimes almost obsolete, as on one side in the type of *Taranga dubia*. The recurrent nervures are usually interstitial with the transverse cubital nervures, but where the second cubital cell is reduced the first recurrent is received before the apex of the first cubital cell. I can find absolutely no difference between Australian and New Zealand specimens, and have no doubt that the species has been imported into the latter country during the last century.

Hab. Eaglehawk Neck, Tasmania (*Turner*), February; Mt. Wellington, Tasmania (*Turner*), January; Mt. Lofty, S.A. (*Wesche*), November; Taralga, N.S.W. (*Dr. Broom*); Toowoomba, Q. (*Higlett*); Wellington, New Zealand (*Cockayne*), December.

30. PISON CONGENER, sp. n.

♀. Nigra; segmentis dorsalibus 1-3 apice anguste albo-pilosis; alis fusco-hyalinis, venis nigris; mesonoto punctato; segmento ventrali secundo in disco sparse punctato.

Long., ♀ 14 mm., ♂ 12 mm.

♀. Clypeus rounded at the apex, slightly but broadly produced in the middle of the apical margin, closely and very finely punctured and clothed with greyish pubescence. Second joint of the flagellum distinctly longer than the third. Posterior ocelli further from the eyes than from each other, separated from the eyes by a distance equal to about twice their own diameter; eyes about half as far again from each other on the clypeus as on the vertex. Thorax closely and distinctly punctured. Median segment finely and closely punctured, with delicate, irregular, oblique striæ at the base, with a distinct median sulcus, but without a carina, the posterior slope punctured, with indistinct transverse striæ and a strong median sulcus. Abdomen closely microscopically punctured, the two basal segments slightly depressed on the apical margin, the ventral segments more strongly and sparsely punctured, the second and third ventral segments more sparsely punctured in the middle than at the sides. Second abscissa of the radius fully as long as the petiole of the second cubital cell, recurrent nervures interstitial with the transverse cubital nervures.

♂. The clypeus is distinctly pointed at the apex; the eyes a little further apart on the vertex than in the female, and the sculpture of the median segment a little coarser.

Hab. Yallingup, S.W. Australia (*Turner*), December.

This is very near *spinolæ*, but is distinguished by the punctured thorax and the greater distance between the eyes on the vertex.

31. *PISON SCABRUM* Turn.

Pison scabrum Turn. Proc. Zool. Soc. London, p. 509 (1908), ♀.

This species has the thorax and median segment much more coarsely punctured than in *congener*, the second abscissa of the radius is also much longer, and the eyes are further apart on the clypeus. It is very near *P. nitidus* Sm., from Aru, but has the eyes further apart on the vertex than in that species, and the sculpture of the median segment coarser, with a much less distinct sulcus.

Hab. Mackay, Q. (*Turner*).

32. *PISON PUNCTULATUM* Kohl.

Pison punctulatum Kohl, Verh. zool.-bot. Ges. Wien, xxxiii. p. 336 (1883), ♀ ♂.

Easily distinguished by the coarse puncturation of the head, thorax, and median segment, and by the strongly constricted abdominal segments. The punctures of the dorsal segments are very distinct; the second ventral segment is rather sparsely punctured, especially in the middle. The antennæ are short and rather stout. The nearest relation is *P. constrictum* Turn., from New Guinea, but the sculpture is much less coarse in that species, and the puncturation of the second ventral segment is different.

Hab. Mackay, Q. (*Turner*), December.

33. *PISON AURIVENTRE* Turn.

Pison auriventre Turn. Proc. Zool. Soc. London, p. 512 (1908), ♀.

The abdomen in this species is almost entirely covered with golden pubescence, which forms denser bands on the apical margins of the segments. There is a spot of silver pubescence at the apical angles of the first dorsal segment.

Hab. Victoria (*French*); Brisbane, Q. (*Hacker*), September.

34. *PISON DIVES*, sp. n.

♀. Nigra; segmentis abdominalibus apice anguste brunneis; tegulis calcariisque fuscis, clypeo argenteo-piloso; abdomine aureo-piloso; alis subhyalinis, venis fusco-ferrugineis.

Long. 10 mm.

♀. Clypeus closely and very finely punctured, broadly and roundly produced on the middle of the apical margin, the

produced portion smooth and shining. Antennæ not very stout, the second joint of the flagellum distinctly, but very slightly, longer than the third, more than twice as long as the first. Posterior ocelli as far from the eyes as from each other, separated from each other by a distance less than the diameter of one ocellus; eyes almost twice as far apart on the clypeus as on the vertex. Head and thorax opaque, microscopically punctured. Median segment finely and closely obliquely striated; the median sulcus very distinct, but not reaching the base, without a distinct carina, the posterior slope transversely striated. Abdomen covered with golden pubescence, on the dorsal segments forming denser apical fasciæ. Petiole of the second cubital cell shorter than the second abscissa of the radius and no longer than the height of the second cubital cell; transverse median nervure interstitial with the basal nervure.

Hab. Kuranda, Q. (*Turner*), May.

This is allied to *auriventre*, but is distinguished by the shape of the clypeus, the lesser distance between the eyes on the vertex and between the posterior ocelli, and by the striation of the whole dorsal surface of the median segment, the striation in *auriventre* being confined to the extreme base and almost obsolete. In both species the second ventral segment is very finely, closely, and evenly punctured.

35. PISON SIMILLIMUS Sm.

Pison simillimus Sm. Trans. Ent. Soc. London, p. 292 (1869), ♂.

This may be distinguished from *marginatum* and other allied species by the very distinct oblique striation of the dorsal surface of the median segment. The tibiæ and tarsi are ferruginous, the apical margins of the dorsal segments brown. In the male the posterior ocelli are a little nearer to each other than to the eyes, but in the female the distances are about equal; the male has the clypeus produced into a spine, that of the female being very broadly rounded. The second abscissa of the radius is as long as or longer than the petiole of the second cubital cell, and the first recurrent nervure is received just before the apex of the first cubital cell.

Hab. Victoria (*French*).

36. PISON MARGINATUS Sm.

Pison marginatus Sm. Cat. Hym. B. M. iv. p. 314 (1856), ♀.

This species has the median segment very closely and finely punctured, the punctures intermingled with very delicate striæ, which are not visible in all lights. The margins of the abdominal segments are rather broadly brown, with fasciæ of pale, dull, fulvous pubescence.

Hab. Melbourne, Victoria (*French*); Mackay, Q. (*Turner*), October.

37. *PISON SEPARATUS* Sm.

Pison separatus Sm. Trans. Ent. Soc. London, p. 294 (1869), ♂.

Very near *marginatus*, but may be distinguished by the sparser punctures of the median segment and the absence of striæ, and by the somewhat longer spine of the male clypeus. The colour of the tarsi is a little more ferruginous. I have not seen the female, but it is not improbable that when more material is available it will prove to be merely a western form of *marginatus*.

Hab. Champion Bay, W.A. (*Du Boulay*).

38. *PISON TIBIALIS* Sm.

Pison tibialis Sm. Trans. Ent. Soc. London, p. 292 (1869), ♂.

The male has the clypeus produced into a spine at the apex; the antennæ stout and rather short, the second joint of the flagellum nearly equal to the combined length of the first and third; the posterior ocelli nearer to each other than to the eyes, which are nearly half as far again from each other on the clypeus as on the vertex. The median segment is short and broad, and the insect is of robust build in proportion to the length. The female has the clypeus rounded, somewhat bluntly produced in the middle of the apical margin; the second joint of the flagellum a little shorter in proportion than in the male; the posterior ocelli as near to the eyes as to each other, and the eyes fully half as far again from each other on the clypeus as on the vertex.

Hab. Western Australia (*Du Boulay*); Kalamunda, W.A. (*Turner*), February to April; Brisbane, Q. (*Hacker*), December.

39. *PISON FRATERCULUS*, sp. n.

♀. Nigra; tegulis segmentisque abdominalibus fascia lata apicali brunneis; femoribus apice, tibiis tarsisque ferrugineis; segmentis dorsalibus fascia apicali pallide fulvo-pilosa; alis sordide hyalinis, venis fusco-ferrugineis.

♂. *Feminæ similis.*

Long., ♀ 10 mm., ♂ 9.5 mm.

♀. Clypeus microscopically punctured, opaque, clothed with whitish pubescence, bluntly produced and rounded in the middle of the apical margin. Head and thorax minutely punctured; the front clothed with whitish pubescence as high as the emargination of the eyes, without a frontal sulcus; second joint of the flagellum a little longer than the third, but shorter than the first and third combined. Posterior ocelli a little nearer to the eyes than to each other, separated from the eyes by a distance considerably less than their own diameter; the eyes more than half as far again from each other on the clypeus as on the vertex. Median segment finely and closely punctured, the median sulcus and carina distinct, but not very strong; the

posterior slope punctured at the base, transversely striated at the apex, the median sulcus deep at the base, but not extending on to the striated portion. Abdomen microscopically punctured, the segments not constricted; second ventral segment finely and evenly punctured. Recurrent nervures interstitial with the transverse cubital nervures; second abscissa of the radius slightly shorter than the petiole of the second cubital cell; transverse median and basal nervures interstitial.

♂. Clypeus produced into a short spine at the apex; posterior ocelli separated from the eyes by a distance fully equal to their own diameter; second abscissa of the radius a little longer than the petiole of the second cubital cell.

Hab. Mackay, Q. (*Turner*), January and February.

Very near *tibialis*, but the eyes are nearer together on the vertex, the sculpture of the thorax and median segment is finer, the second abscissa of the radius is much shorter, and the whole insect is of more slender build, the median segment being longer and more narrowed to the apex.

40. PISON MERIDIONALE, sp. n.

♂. Niger; antennis articulis quatuor basalibus, mandibulis, tegulis pedibusque, coxis exceptis, ferrugineis; segmentis dorsalibus apice late brunneis, fascia apicali aureo-pubescente; alis hyalinis, iridescentibus, venis fuscis.

Long. 9.5 mm.

♂. Clypeus minutely punctured, produced into a short spine at the apex, covered with whitish pubescence, which extends on the front as high as the emargination of the eyes. Second joint of the flagellum very little longer than the third. Posterior ocelli as far from the eyes as from each other, separated from the eyes by a distance about half as great again as their own diameter; eyes half as far again from each other on the clypeus as on the vertex. Head and thorax minutely punctured. Median segment finely punctured-striate, the striæ oblique and indistinct, most distinct at the base; the median sulcus distinct, but shallow, the carina only developed at the extreme base; the posterior slope coarsely transversely striated. Abdomen very finely and closely punctured; the basal segment short, a little depressed at the apex; second ventral segment closely and evenly punctured; seventh dorsal segment broadly truncate at the apex. Recurrent nervures interstitial with the transverse cubital nervures; second abscissa of the radius longer than the petiole of the second cubital cell; transverse median nervure received just beyond the basal nervure, not quite interstitial.

Hab. Adelaide, S.A.

Near *tibialis*, but differs in the colour of the legs and antennæ, in the lesser breadth between the eyes on the vertex, in the finer sculpture of the thorax, and in the sculpture of the median segment.

41. *PISON DECIPIENS* Sm.

Pison decipiens Sm. Trans. Ent. Soc. London, p. 295 (1869), ♂.

More nearly allied to *dimidiatum* than to any other species, but differs in the colour of the abdomen, the somewhat longer median segment, and in the whiter pubescence of the head and thorax. The clypeus is also less deeply sinuate on each side of the apical spine.

Hab. Champion Bay, W.A. (*Du Boulay*).

42. *PISON INCONSPICUUM*, sp. n.

♂. Niger; mandibulis, tegulis pedibusque, coxis exceptis, ferrugineis; trochanteribus anticis femoribusque anticis basi nigricantibus; segmentis dorsalibus apice anguste fusco-brunneis, fascia apicali sparse albido-pubescente; alis hyalinis, venis fuscis.

Long. 5.5 mm.

♂. Clypeus produced into a long spine at the apex, deeply sinuate on each side of the spine, covered with silver pubescence, which extends on the front as high as the emargination of the eyes. Antennæ rather short and stout, the second joint of the flagellum a little longer than the third. Ocelli in an equilateral triangle, the posterior pair as far from the eyes as from each other, separated from the eyes by a distance equal to at least twice their own diameter; the eyes no further apart on the clypeus than on the vertex. Head very much broader than the thorax, very minutely punctured, the frontal sulcus almost obsolete, only visible just below the anterior ocellus; thorax a little more distinctly punctured than the head. Median segment finely granulate, with a few indistinct oblique striæ at the base; median sulcus very shallow, the median carina distinct. Abdomen microscopically punctured, more distinctly punctured on the ventral surface; second ventral segment finely and evenly punctured; seventh dorsal segment dull ferruginous, broadly truncate at the apex. Recurrent nervures interstitial with the transverse cubital nervures; second abscissa of the radius shorter than the petiole of the second cubital cell; transverse median nervure interstitial with the basal nervure.

Hab. Mundaring Weir, W.A. (*Turner*), March 18, 1914.

The anterior margin of the clypeus is shaped as in *dimidiatus*, to which species and *decipiens* the relationship is close. But the eyes are much closer together on the clypeus than in either of those species, and the colour of the abdomen is different, the apical chitinous fasciæ being much darker than in *decipiens*, also the antennæ are entirely black.

43. *PISON AURIFEX* Sm.

Pison aurifex Sm. Trans. Ent. Soc. London, p. 293 (1869), ♀ ♂.

I have seen no recent specimens of this beautiful species. It is of much more slender build than *vestitus* or *aureosericeum*, the shape of the first abdominal segment being much more elongate.

All the dorsal and ventral segments have broad chitinous bands of brown, covered on the four basal dorsal segments with golden pubescence.

Two females and one male in the British Museum, all from Smith's collection.

Hab. Australia.

44. *PISON VESTITUS* Sm.

Pison vestitus Sm. Cat. Hym. B. M. iv. p. 315 (1856), ♀.

The type is unique in the British Museum, without any data to show whence it was received. At one time I confused it with *pulchrinum*, but it differs as pointed out in the description of that species. There is a minute tubercle on each side of the mesosternum, as in *auratus* and *aureosericeum*.

Hab. Australia.

45. *PISON PULCHRINUM*, sp. n.

♀. Nigra; mandibulis, antennis articulis quinque basalibus, tegulis, femoribus apice, tibiis tarsisque ferrugineis; segmentis dorsalibus 3-6, ventralibus 2-6 fascia apicali brunnea; segmento dorsali primo fascia apicali aureo-pubescente; fronte dense, thorace segmentoque mediano sparsius aureo-pilosis; alis hyalinis, venis fuscis.

♂. Feminae similis.

Long., ♀ 13 mm., ♂ 10 mm.

♀. Clypeus very broadly rounded or subtruncate at the apex, clothed with golden pubescence, which extends on the front as high as the emargination of the eyes. Second joint of the flagellum longer than the third, about equal in length to the first and third combined. Posterior ocelli a little further from each other than from the eyes, separated from the eyes by a distance slightly exceeding their own diameter; eyes more than half as far again from each other on the clypeus as on the vertex. Front somewhat convex, the frontal sulcus indistinct; the punctures of the head microscopic. Thorax rather more distinctly punctured, the pronotum and postscutellum clothed with golden pubescence. Mesosternum with a minute tubercle on each side. Median segment short and broad, finely punctured, clothed with pale golden pubescence; the median sulcus distinct, but shallow, the median carina not reaching the apex; the apical slope coarsely transversely striated, with a deep median sulcus. Abdomen microscopically punctured; the basal segment short and broad, a little depressed at the apex, with a broad band of golden pubescence, second segment without an apical band of pubescence, the bands on the third and fourth segments fairly broad. Recurrent nervures interstitial with the transverse cubital nervures; second abscissa of the radius longer than the petiole of the second cubital cell; transverse median nervure received beyond the basal nervure.

♂. Clypeus with a small spine in the middle of the apical

margin; the pubescence on the whole insect paler; seventh dorsal segment widely emarginate at the apex.

Hab. Mackay, Q. (*Turner*), December to April; Kuranda, Q. (*Turner*), March to July.

In this species there is no band of golden pubescence on the second dorsal segment, which is present in *vestitus*, the antennæ in that species are black, and the legs piceous, almost black. The eyes are nearer together in *vestitus* than in *pulchrinum*, both on the clypeus and vertex, though the difference in this point is slight.

46. *PISON EXORNATUM*, sp. n.

♀. Nigra; mandibulis, antennis articulis septem basalibus, tegulis, femoribus apice, tibiis, tarsis, abdomine segmento primo, segmentoque quinto margine apicali pallide ferrugineis; alis hyalinis, venis fusco-ferrugineis.

Long. 11-13 mm.

♀. Extremely near *P. pulchrinum*, from which it differs in the ferruginous colour of the first abdominal segment, in the absence of brown chitinous and golden pubescent apical bands on the third and fourth dorsal segments, in the slightly less distance between the eyes on the clypeus, and in the distinctly narrower median segment. The distribution of the golden pubescence on the head, thorax, and median segment, also on the apical band of the first dorsal segment, is the same in both species.

Hab. Mackay, Q. (*Turner*), May.

47. *PISON AUREOSERICEUM* Rohw.

Pison aureosericeum Rohw. Proc. U.S. Nat. Museum, xlix. p. 246 (1915), ♀ ♂.

This species also strongly resembles *pulchrinum*, except in colour, the ferruginous colour of the legs including the whole of the femora and trochanters; the first abdominal segment is also ferruginous, and there is a broad ferruginous apical band on the second segment; the three apical segments are almost wholly ferruginous. The apical dorsal segment of the male is broadly truncate, not emarginate as in *pulchrinum*.

Hab. Kuranda, Q. (*Turner*), February; Mackay, Q. (*Turner*), February and March; Duaringa, Q. (*U.S. Museum*); Victoria (*French*).

48. *PISON AURATUS* Shuck.

Pison auratus Shuck. Trans. Ent. Soc. London, ii. p. 78 (1837), ♀.

This is extremely near *aureosericeum*, with which species I had at one time confused it, but it differs in the distinctly longer median segment and in the wholly ferruginous colour of the second ventral segment. The striation of the posterior slope of the median segment is much less coarse than in *aureosericeum*.

Hab. Port Darwin (*Dodd*).

49. *PISON EXULTANS*, sp. n.

♂. Niger; mandibulis, antennis apice infuscatis, tegulis, abdomine segmento primo utrinque nigro-maculato, segmento septimo, femoribus apice, tibiis tarsisque ferrugineis; segmentis 3-6 apice late brunneo-fasciatis; alis sordide hyalinis, venis nigris.

Long. 8 mm.

♂. Clypeus short and broad, the apical margin subtruncate, produced into a point in the middle; antennæ rather stout, distinctly thickened towards the apex, second joint of the flagellum a little longer than the third, less than twice as long as the first. Posterior ocelli a little further from each other than from the eyes, separated from the eyes by a distance slightly exceeding their own diameter; eyes about half as far again from each other on the clypeus as on the vertex; the frontal sulcus very shallow; clypeus and front as far as the emargination of the eyes clothed with whitish pubescence. Head and thorax opaque, microscopically punctured; pronotum clothed with very pale golden pubescence. Median segment rather long, very closely and minutely punctured, with a row of large punctures at the base; the median sulcus well marked but not deep, the median carina very delicate, with a row of distinct punctures on each side of it in the sulcus; the posterior slope closely and finely punctured, with a strong median sulcus. First abdominal segment elongate, subpetiolate, longer than the second, widened to the apex, with an apical band of rather sparse whitish pubescence, the second segment without an apical chitinous or pubescent band; segments 3-6 with broad pale brown chitinous bands clothed with very pale fulvous pubescence; seventh dorsal segment subtriangular, bluntly pointed at the apex; the whole abdomen closely microscopically punctured, more strongly and sparsely on the ventral than on the dorsal surface. First recurrent nervure received just before the apex of the first cubital cell, second interstitial with the second transverse cubital nervure; second cubital cell small, second abscissa of the radius as long as the petiole of the second cubital cell; transverse median nervure received before the basal nervure.

Hab. Victoria (*French*).

Easily distinguished from the somewhat similarly coloured species of the *auratus* group by the elongate first abdominal segment and the triangular seventh segment.

50. *PISON BASALIS* Sm.

Pison basalis Sm. Trans. Ent. Soc. London, p. 292 (1869), ♀.

This species belongs to the *auratus* group, but may be distinguished by the ferruginous colour of the second dorsal segment. The male has the seventh dorsal segment truncate at the apex, as in *aureosericeum*.

Hab. Mackay, Q. (*Turner*), November.

Old World Species (excluding Australian).

51. PISON (PISONOIDES) OBLITERATUS Sm.

Pison (Pisonoides) obliteratus Sm. Journ. Proc. Linn. Soc., Zool. ii. p. 104 (1857), ♀.

Parapison obliteratus Sm. Trans. Ent. Soc. London, p. 299 (1869).

This must be taken as the type of Smith's subgenus *Pisonoides*, which is the same as his later genus *Parapison*. Though Kohl treats *Pisonoides* as a *nomen nudum*, I certainly cannot follow him.

The present species may be distinguished from other Oriental *Pisonoides* by the first abdominal segment, which is about twice as long as its apical breadth, being narrow throughout, though gradually broadening towards the apex.

Hab. Borneo (*Wallace*); Taiping, Malay Peninsula (*W. B. Orme*); Maulmain, Tenasserim (*Bingham*), November; Kumaon, N.W. India (*Miss A. Brook*), August.

52. PISON (PISONOIDES) AGILIS Sm.

Parapison agilis Sm. Trans. Ent. Soc. London, p. 300 (1869), ♀.

The legs are piceous, almost black, with whitish calcaria, the fore tibiae and tarsi dull ferruginous brown. It is very near *erythropus*, but in that species the legs are bright ferruginous. The second cubital cell in *erythropus* is pointed on the radius, but in *agilis* the second abscissa of the radius is nearly half as long as the first transverse cubital nervure. Bingham states that the eyes in *agilis* are nearer together on the vertex than in *erythropus*, but this is not the case in the type; he has evidently looked at a Ceylon specimen when comparing, the eyes being slightly nearer to each other both on the vertex and clypeus than in the type. The length of the second abscissa of the radius also varies considerably in Ceylon specimens. The other points of difference given by Bingham are either unsatisfactory or not constant. I am inclined to think that the two forms may be merely local forms of one species, with another local race in Ceylon with somewhat narrower spaces between the eyes both on vertex and clypeus.

Hab. Bareilly (*Horne*), type; Ceylon (*Dr. Thwaites*).

53. PISON (PISONOIDES) ERYTHROPUS Kohl.

Parapison rufipes Sm. Trans. Ent. Soc. London, p. 299 (1869), ♀ (nec *Pisonitus rufipes* Schuck., 1837).

Pison erythropus Kohl, Verh. zool.-bot. Ges. Wien, xxxiv. p. 183 (1884).

Hab. N.W. India (*Horne*).

*54. PISON (PISONOIDES) BROWNI Ashm.

Pisonoides browni Ashm. Proc. U.S. National Mus. xxviii. p. 961 (1905), ♂.

I have not seen this species, which appears to be allied to *agilis*, but may be distinguished by the striation of the posterior slope of the median segment, which is punctured in *agilis*.

Hab. Manila (*R. Brown*).

*55. PISON (PISONOIDES) KOREENSIS Rad.

Paraceramius koreensis Rad. Hor. Soc. Ent. Ross. xxi. p. 433 (1887), ♀.

The description of this species is insufficient, but I do not think it is identical with any Indian species.

56. PISON (PISONOIDES) ROTHNEYI Cam.

Pison (Parapison) rothneyi Cam. Mem. Manchester Lit. & Phil. Soc. xli. p. 81 (1896), ♀.

Pison (Parapison) crassicornis Cam. Mem. Manchester Lit. & Phil. Soc. xli. 13, p. 25 (1897), ♂ (as ♀).

These are undoubtedly sexes of one species. I have seen Cameron's types.

Hab. Barrackpore (*Rothney*).

57. PISON (PISONOIDES) DIFFERENS, sp. n.

♀. Nigra, opaca, segmento mediano subnitido; mandibulis, tegulis, segmentis dorsalibus et ventralibus fascia lata apicali, femoribus apice tibiisque brunneo-testaceis; alis hyalinis, iridescentibus, venis fuscis.

Long. 8 mm.

♀. Head and thorax opaque, very closely microscopically punctured; clypeus broadly rounded at the apex; the front with a distinct longitudinal sulcus extending to the anterior ocellus; eyes a little further apart on the clypeus than on the vertex, separated on the clypeus by a distance slightly exceeding the length of the scape and the two basal joints of the flagellum combined; posterior ocelli a little further from each other than from the eyes, separated from the eyes by a distance equal to the diameter of one ocellus. Second and third joints of the flagellum subequal. Median segment slender, shining and microscopically punctured; the dorsal surface nearly as long as the mesonotum and rather strongly narrowed to the apex; the median sulcus broad and distinct, without a median carina, distinctly interrupted between the dorsal and posterior surfaces, with a minute triangular raised area projecting into the sulcus at the base of the segment; the posterior slope minutely punctured, without striæ. Abdomen minutely, closely, and evenly punctured, both on the dorsal and ventral surfaces. Second abscissa of the radius less than half as long as the first transverse cubital

nervure, much shorter than the distance between the recurrent nervures on the cubitus; second recurrent nervure interstitial with the first transverse cubital nervure.

Hab. Shillong, Assam, 5000 ft. (*Turner*), May. 3 ♀ ♀.

Very near *rothneyi*, of which it may prove to be a subspecies, but as there are structural differences it cannot be treated as identical. The ocelli are much smaller, the eyes are further apart both on the clypeus and the vertex, the puncturation of the head is somewhat finer, the median segment has the dorsal surface very distinctly longer and more narrowed to the apex, and the sulcus of the median segment is broadly interrupted between the dorsal and posterior surfaces, not almost continuous as in *rothneyi*. The pronotum is also a little more depressed in the present species. The apical half of the posterior slope of the median segment is finely transversely striated in *rothneyi*, finely punctured in *differeus*.

58. PISON (PISONOIDES) ISOLATUM Turn.

Pison (*Parapison*) *isolatum* Turn. Trans. Linn. Soc. xiv. p. 372 (1911), ♀ ♂.

This is a very distinct species, without chitinous or pubescent bands at the apex of the dorsal segments, being very much nearer to the Australian *erythrocerus* Kohl than to the Asiatic species. The antennæ are much longer than in *erythrocerus*, and the sculpture of the median segment is different.

Hab. Silhouette Island, Seychelles (*Scott*).

59. PISON (PISONOIDES) TESTACEIPES, sp. n.

♂. Niger; mandibulis, palpis, scapo, tegulis, tibiis anticis tarsisque rufo-testaceis; segmento abdominali quarto dimidio apicali, quinto, sexto, septimoque brunneo-testaceis; alis hyalinis, iridescentibus, margine apicali late infuscatis, venis nigris.

Long. 7 mm.

♂. Clypeus broadly truncate at the apex; antennæ rather slender at the base, slightly thickened towards the apex, the second joint of the flagellum only a little longer than the third, about twice as long as the first. Posterior ocelli separated both from each other and from the eyes by a distance about equal to the diameter of one ocellus, further from the anterior ocellus than from each other. Clypeus and front as high as the emargination of the eyes clothed with silver pubescence, the frontal sulcus indistinct, front opaque, finely punctured-rugulose, vertex finely punctured. Eyes half as far again from each other on the clypeus as on the vertex. Pronotum short, much shorter than in *P. xanthopus*; mesonotum and scutellum finely and closely, but distinctly punctured; mesopleuræ more finely punctured, with a fovea in the middle. Median segment closely punctured, with a distinct triangular dorsal area which is obliquely striated at the extreme base, the median sulcus strongly marked, the

carina only visible at the base, the sides of the segment outside the triangular area finely and irregularly striated; the posterior slope more distinctly transversely striated, with a rather indistinct median sulcus. Abdomen microscopically punctured, without fasciæ of pubescence; the first segment rather strongly depressed at the apex, the ventral surface evenly and much more distinctly punctured; the seventh ventral segment very shallowly emarginate at the apex. Second cubital cell almost pointed on the radius, first transverse cubital nervure a little nearer to the first than to the second recurrent nervure, transverse median nervure received before the basal nervure.

Hab. Zungeru, N. Nigeria (*J. W. Scott-Macfie*), November.

This is very distinct from *xanthopus* in the sculpture of the median segment as well as in the neururation, also in the structure of the apical ventral segments.

60. *PISON ARGENTATUS* Shuck.

Pison (*Pisonitus*) *argentatus* Shuck. Trans. Ent. Soc. London, ii. p. 79 (1837).

Pison fuscipalpe Cam. Proc. Zool. Soc. London, ii. p. 27 (1901).

Pisonitus argenteus Ashm. Proc. U.S. National Mus. xxviii. p. 131 (1904).

This is a very wide-ranging species, and the original habitat is doubtful. In recent years it has been imported into Hawaii, where it has increased rapidly, apparently to the detriment of the indigenous species. There seems to be some slight variation in the intensity of the sculpture of the median segment, but nothing of specific importance.

Hab. Mauritius (*Shuckard*), type; Madagascar (*Saussure*); Rangoon (*Bingham*), April; Amherst, Tenasserim (*Bingham*), April; Singapore (*Cameron*); Borneo (*ex coll. Cameron*); Bacoar, Philippines (*Ashmead*); Oahu, Hawaii (*Perkins*), July.

61. *PISON RUGOSUS* Sm.

Pison (*Pisonitus*) *rugosus* Sm. Cat. Hym. B. M. iv. p. 313 (1856), ♀.

Pison appendiculatum Cam. Mem. Manchester Lit. & Phil. Soc. xli. 13, p. 24 (1897).

Easily distinguished from *argentatus*, the only other Oriental species of the *Pisonitus* section, by the much coarser puncturation of the head and thorax and the stronger constriction of the abdominal segments. Intermediate in neururation between *Pisonitus* and *Pison*.

Hab. N.W. Provinces of India, throughout N.E. India and Burma; Poona, W. India.

62. *PISON ATER* Spin.

Alyson ater Spin. Ins. Lig. ii. 4, p. 253 (1808), ♀.

Pison jurini Spin. Ins. Lig. ii. 4, p. 256 (1808), ♂.

Tachybulus niger Latr. Gen. Crust. et Ins. iv. p. 75 (1809), ♀.

Pison atrum Kohl, Verh. zool.-bot. Ges. Wien, xxxiv. p. 184, ♂.

This is the best-known European species, though far from common. It may be distinguished from the other South European species *P. sericeum* by the sculpture of the median segment, which is punctured in *ater*, finely obliquely striated in *sericeum*, and by the much greater distance between the posterior ocelli and eyes of *sericeum*, equal in the male of that species to twice the diameter of an ocellus, in the male of *ater* only equal to the diameter of an ocellus. In *sericeum* also the margins of the abdominal segments are dark brown, in *ater* black. The size of *ater* is also considerably less than that of *sericeum*.

Hab. Genoa (*Spinola*); S. France (*Latreille*); Albania (*Saunders*); Switzerland (*Kohl*); Gibraltar (*Walker*).

63. PISON SERICEUM Kohl.

Pison sericeum Kohl, Verh. zool.-bot. Ges. Wien, xxxviii. p. 140 (1888), ♂.

Hab. Attica (*Kohl*); Italy (*ex coll. F. Smith*).

*64. PISON ASSIMILE Sickm.

Pison assimile Sickm. Zool. Jahrb. viii. p. 212 (1895), ♀.

Very similar to *P. ater*, but more finely punctured.

Hab. Tientsin.

65. PISON FASCIATUS Rad.

Pseudonysson fasciatus Rad. Horæ Soc. Ent. Ross. xii. p. 105 (1876), ♂; Rad. Bull. Soc. Nat. Moscou, p. 592 (1891).

The description is poor, but apparently the species is allied to *algiricum*, but with normal antennæ. To this species I assign an Indian specimen with some doubt.

Hab. S.E. Caucasus; Chapra, Bengal (*Mackenzie*).

*66. PISON SUSPICAX Kokuji.

Pison suspicax Kokuji, Mitt. Kaukas. Mus. vii. p. 6 (1912), ♂.

This may be distinguished from all other Palearctic species by the golden pubescence of the head and abdominal fasciæ.

Hab. Caucasus.

67. PISON ALGIRICUM Kohl.

Pison algiricum Kohl, Termes Fuz. xxi. p. 353 (1898), ♀ ♂.

In the male sex this is distinguished by the thickening of the third to sixth joints of the flagellum beneath, near the apex. A somewhat similar structure, much more strongly developed, but confined to the third and fourth joints, is seen in the Australian *P. fenestratus* Sm. Kohl compares the present species with *fasciatus* Rad., in which the antennæ are normal.

Hab. Oran (*Schmiedeknecht*); Marakesh (*Escalera*), April.

68. *PISON REGALIS* Sm.

Pison regalis Sm. Trans. Ent. Soc. London, (2) ii. p. 34 (1852), ♀ ♂.

Allied to *insigne* Sickm., but much larger; the male has similar transverse ridges on the second, third, and fourth ventral segments, which appear also in a rudimentary form on the second and third segments of the female. But it differs from *insigne* in the absence of a tubercle on the mesopleuræ before the intermediate coxæ, and in the absence of a transverse depression on the mesosternum. The apical ventral segment of the male is very deeply emarginate, with a long spine on each side.

Hab. Ning-po-foo, China (*Fortune*); Hsikou, near Tientsin (*F. M. Thomson*), June.

*69. *PISON INSIGNE* Sickm.

Pison insigne Sickm. Zool. Jahrb. viii. p. 210 (1895), ♂.

Differs from *P. regalis* as noticed above; the mesonotum is also more sparsely and finely punctured.

Hab. Nankou Pass, N. China (*Weber*).

70. *PISON XANTHOPUS* Brullé.

Nephridia xanthopus Brullé, Ann. Soc. Ent. France, ii. p. 408 (1833).

Pison obscurus Shuck. Trans. Ent. Soc. London, ii. p. 75 (1837), ♀ ♂.

A wide-ranging African species in which the median segment is strongly obliquely striated, the three or four apical abdominal segments in the male more or less red; the clypeus in the male is somewhat angular in the middle on the apical margin, but not produced into a tooth, that of the female very broadly rounded or subtruncate; the posterior ocelli further from each other than from the eyes, separated from the eyes by less than the diameter of an ocellus. The position of the second recurrent nervure is variable.

Hab. Meadi, Egypt (*Egyptian Department of Agriculture*), July; Entebbe, Uganda (*C. G. Gowdey*), March, August, and September; Obuasi, Ashanti (*Dr. Graham*), February to April; Sierra Leone (*Morgan*).

*71. *PISON MONTANUS* Cam.

Pison montanus Cam. in Sjöstedt, Kilimandj. Meru Exp. ii. p. 289 (1910), ♂.

The description is poor, but from the coarse sculpture the relationship would seem to be nearest to *allonymum*.

Hab. Kibonoto, Kilimandjaro.

72. *PISON ALLONYMUM* Schulz.

Pison iridipennis Cam. Rec. Albany Mus. i. p. 261 (1905), ♂ (nec Smith, 1879).

Pisum allonymum Schulz, Spolia Hymen. p. 213 (1906).

The head, thorax, and median segment are coarsely punctured, the eyes very far apart on the vertex, nearly as far as on the clypeus, the posterior ocelli further from the eyes than from each other. I do not think that this can be *rhodesianum* Bisch., the distance between the eyes being so much greater than in *ater*, and the puncturation much coarser.

Hab. Dunbrody (*O'Neill*); Willowmore (*Dr. Brauns*); Mid Luangwa River, N.E. Rhodesia (*Neave*), August; Nawalia, Niamadzi River, N.E. Rhodesia (*Neave*), August.

*73. *PISON RHODESIANUM* Bisch.

Pison rhodesianum Bisch. Arch. f. Naturg. A. 3, p. 75 (1913), ♀.

From the description this seems to be very near *P. ater*, with which Bischoff compares it. I consider that it is certainly distinct from any of the African species described by Cameron.

Hab. Buluwayo; October.

74. *PISON TRANSVAALENSIS* Cam.

Pison transvaalensis Cam. Ann. Transv. Mus. ii. p. 152 (1910), ♂.

A specimen of this species, labelled "type" by Cameron, is in the British Museum. It is from the Cameron collection, and is a female; but Cameron was accustomed to label all specimens before him "type," not only one. The species is very near *denticeps*, and I am inclined to think that Cameron has mistaken the sex of his type, and that *denticeps* is really the male of *transvaalensis*, in which case the latter name would stand. But the position of the first recurrent nervure is different. The posterior ocelli in *transvaalensis* are very close to the eyes.

Hab. Pretoria.

75. *PISON DENTICEPS* Cam.

Pison denticeps Cam. Ann. Transv. Mus. ii. p. 153 (1910), ♂.

This may be distinguished from *xanthopus* by the finer striation of the median segment, the less constricted abdominal segments, the apical ventral segment is produced into two points as is usual in the genus, not into one only as in *xanthopus*; the clypeus also has a distinct spine at the apex, and the front is more distinctly convex. This species is remarkable as showing a transition in neuration from *Pison* to *Pisonoides*, the second transverse cubital nervure being sometimes entirely absent, but sometimes represented by a stump: probably a long series would show the full transition.

Hab. Transvaal.

*76. *PISON CLYPEATUS* Cam.

Pison clypeatus Cam. Ann. Transv. Mus. ii. p. 153 (1910), ♀.

Evidently allied to *xanthopus*, but the clypeus is narrowed to a sharp point in the centre, the striation of the median segment is coarser, and the second abscissa of the radius longer.

Hab. Warmberg, Zoutpansberg district; October.

77. *PISON INÆQUALE*, sp. n.

♂. Niger; mandibulis apice fusco-ferrugineis; tegulis calcarisque brunneis; alis hyalinis, apice late infuscatis, iridescentibus, venis nigris; cellula cubitali secunda minutissima aut oblitterata.

Long. 7 mm.

♂. Clypeus broad, produced into a short spine in the middle of the apical margin; clothed with silver pubescence, which extends on the front as high as the emargination of the eyes. Second joint of the flagellum very slightly longer than the third; eyes separated on the clypeus by a distance half as great again as that separating them on the vertex; posterior ocelli as far from the eyes as from each other, separated from the eyes by a distance exceeding the diameter of an ocellus. Front closely punctured-rugose, the frontal sulcus obsolete, except just below the anterior ocellus, the vertex closely and rather coarsely punctured. Pronotum short, as in *P. ater*; mesonotum and scutellum coarsely punctured, but less closely than the vertex, more coarsely than in *P. ater*; pleuræ very closely punctured, but more finely than in *P. ater*. Median segment with a deep median sulcus which is very widely forked close to the base, enclosing a very small basal area, the branches of the sulcus obliquely striated, the main sulcus extending to the apex of the segment, with a strong median carina not quite reaching the apex; on each side of the sulcus the segment is very closely and finely punctured, with numerous, fine, irregular striæ; the apical slope coarsely punctured-rugose, with a deep median sulcus. Abdomen finely punctured, the segments moderately depressed at the apex, the apical bands of white pubescence well defined laterally, but not distinct in the middle, the basal segment more sparsely and strongly punctured than the second, the apical segments very closely and minutely punctured; the ventral segments more sparsely but evenly punctured; apical ventral segment very shallowly emarginate, the angles not produced into points. Second abscissa of the radius very short, second cubital cell obliterated on the left side, very minute on the right, second recurrent nervure on the right side interstitial with the second transverse cubital nervure, first received before the apex of the first cubital cell. Basal and transverse median nervures interstitial.

Hab. Mlanje, Nyassaland (*S. A. Neave*), 2300 ft., October.

Very near *ater* and *rhodesianus*, but differs in the sculpture,

especially on the thorax and median segment; also in the reduction of the second cubital cell. It also differs in these characters from *montanus*. There is no impressed line behind the posterior ocelli.

78. *PISON WOLLASTONI*, sp. n.

♀. Nigra, albo-pilosa; tegulis apice pallide brunneis; alis hyalinis, apice late infumatis, venis nigris, stigmatibus fusco-ferrugineo.

Long. 11 mm.

♀. Clypeus produced into a point at the apex, punctured finely and closely, and clothed with rather long whitish pubescence which extends on the front as far as the emargination of the eyes. Antennæ rather slender, not thickened towards the apex, the second joint of the flagellum distinctly longer than the third, but shorter than the first and third combined. Posterior ocelli nearer to the eyes than to each other, separated from the eyes by a distance considerably less than the diameter of one ocellus; the eyes nearly twice as far from each other on the clypeus as on the vertex. Front punctured-rugose, the vertex and ocellar space more finely punctured; pronotum short, steeply sloped anteriorly; mesonotum and mesopleura coarsely punctured, scutellum more finely and sparsely punctured. Median segment closely punctured-rugose, the median sulcus shallow and not extending to the apex, the median carina distinct; the posterior slope rugose, with a shallow median sulcus. Abdomen smooth and shining on the dorsal surface, the segments scarcely depressed at the apex, the apical fasciæ of white pubescence confined to the sides; the ventral segments sparsely but distinctly punctured. Second abscissa of the radius shorter than the petiole of the well-developed second cubital cell; second recurrent nervure interstitial with the second transverse cubital nervure, first received by the second cubital cell close to the base; basul and transverse median nervures interstitial.

Hab. St. Helena (*Wollaston*).

A very distinct species, not at all nearly allied to any Ethiopian form.

79. *PISON SPECULARE* Turn.

Pison speculare Turn. Trans. Linn. Soc. xiv. p. 371 (1911), ♀.

The posterior ocelli almost touch the eyes: the puncturation of the whole insect is very delicate, microscopic on both dorsal and ventral segments of the abdomen.

Hab. Praslin, Seychelles (*Scott*).

80. *PISON KOHLII* Bingh.

Pison kohlii Bingh. Fauna Brit. India, Hymen. i. p. 220 (1897), ♀.

Pison aureopilosus Cam. Soc. Entom. xxiv. p. 73 (1909).

Easily distinguished from *punctifrons* by the golden pubescence of the head and abdomen, by the almost obsolete puncturation of the mesonotum, and by the coarse longitudinal striation of the median segment, the striation in *punctifrons* being oblique.

Hab. Dawnat Range, Tenasserim (*Bingham*), December; Borneo (*Cameron*).

81. *PISON PUNCTIFRONS*, Shuck.

Pison punctifrons Shuck. Trans. Ent. Soc. ii. p. 77 (1837), ♀.

Pison suspiciosus Sm. Journ. Proc. Linn. Soc., Zool. ii. p. 104 (1858), ♀.

Pison fabricator Sm. Trans. Ent. Soc. London, p. 297 (1869), ♀.

Pison striolatum Cam. Mem. Manchester Lit. & Phil. Soc. xli. p. 82 (1896).

Pison javanus Cam. Tijdsch. f. Entom. xlviii. p. 63 (1905), ♂.

I think all these are identical—certainly the first four, and almost certainly *Cameron's* species also.

Hab. Yunzalin Valley, Tenasserim (*Bingham*), April; Rangoon (*Bingham*), May; Singapore (*Wallace*); Samarang, Java (*Drescher*); Ceylon (*Thwaites*); Hong Kong (*Smith*); Foo-Chow (*Rickett*).

82. *PISON ORIENTALE* Cam.

Pison orientale Cam. Mem. Manchester Lit. & Phil. Soc. xli. 13, p. 23 (1897).

Hab. Barrackpore (*Rothney*).

*83. *PISON LAGUNÆ* Ashm.

Pison lagunæ Ashm. Proc. U.S. National Mus. xxviii. p. 131 (1904), ♂.

I suspect that this will prove to be a synonym of *punctifrons*, but the description is too poor for certainty.

Hab. Laguna, Philippines (*Stangl*).

*84. *PISON ASHMEADI*, nom. nov.

Pison punctulatus Ashm. Proc. U.S. National Mus. xxviii. p. 960 (1905), ♂ (nec *P. punctulatum* Kohl, 1883).

I cannot identify this species.

Hab. Manila (*Brown*).

85. *PISON PALLIDIPALPIS* Sm.

Pison pallidipalpis Sm. Journ. Proc. Linn. Soc., Zool. vii. p. 35 (1863), ♀.

Closely allied to *insularis* Sm. and *priscum* Turn. The puncturation of the second ventral segment is microscopic.

Hab. Ceram (*Wallace*).

86. *PISON INSULARIS* Sm.

Pison insularis Sm. Trans. Ent. Soc. London, p. 297 (1869), ♀.

Very near *priscum* Turn., but differs as pointed out under that species. The second ventral segment is shining and smooth.

Hab. New Hebrides.

*87. *PISON GLABRUM* Kohl.

Pison glabrum Kohl, Denkschr. Akad. Wiss. Wien, lxxxi. p. 309 (1908), ♀.

This seems to be very near *insularis* in sculpture; but the wings are infusate: and either the eyes are further apart on the vertex or the basal joints of the flagellum are shorter.

Hab. Upolu, Samoa (*Reckinger*).

*88. *PISON STRICTIFRONS* Vachal.

Pison strictifrons Vachal, Revue d'Entom. xxvi. p. 114 (1907), ♀.

A much smaller species than *insularis*, though agreeing with it in nearness of the posterior ocelli to the eyes and in the smooth median segment. The description is very insufficient.

Hab. New Caledonia.

89. *PISON IMPUNCTATUM* Turn.

Pison impunctatum Turn. Ann. & Mag. Nat. Hist. (8) ix. p. 200 (1912), ♀.

Probably closely allied to *strictifrons*, also to *iridipennis* Sm. From the latter it differs in the lesser distance between the eyes on the vertex and the smoother median segment.

Hab. New Guinea (*Wollaston*).

90. *PISON IRIDIPENNIS* Sm.

Pison iridipennis Smith, Journ. Linn. Soc., Zool. xiv. p. 676 (1879), ♂; Smith, Descr. New Spec. Hymen. p. 139 (1879), ♂.

Hab. Hawaii; Koolau, July; Samoa.

91. *PISON TUBERCULATUS* Sm.

Pison tuberculatus Sm. Trans. Ent. Soc. London, p. 296 (1869), ♂.

A small species closely allied to *iridipennis*, but whereas that species has in the male a short transverse ridge on the third ventral segment and a similar but less distinct ridge on the fourth, *tuberculatus* has a rounded tubercle on each side of the third ventral segment and a similar but less distinct tubercle on each side of the second and fourth.

Hab. New Zealand.

92. *PISON MOROSUS* Sm.

Pison morosus Sm. Cat. Hym. B. M. iv. p. 317 (1856), ♀ (nec Smith, 1864).

Much larger than *tuberculatus*, and has no tubercles on the ventral segments of the male. It appears to be the commoner of the two indigenous species in New Zealand; the third species, *P. spinolæ*, being a comparatively recent importation.

Hab. New Zealand.

93. *PISON TAHITENSE* Sauss.

Pison tahitense Sauss. Reise d. Novara, Zool. ii., Hymen. p. 65 (1867), ♀ ♂.

Allied to *P. hospes*, but has the eyes nearer together both on the vertex and the clypeus, and the clypeus of the male more strongly produced.

Hab. Tahiti; Samoa; Rarotonga.

*94. *PISON COLLARE* Kohl.

Pison collare Kohl, Verh. zool.-bot. Ges. Wien, xxxiii. p. 337 (1883), ♀.

The clypeus of the female is produced into an acute spine; the front coarsely punctured; the median segment shining and sparsely punctured, with a few transverse striæ near the apex of the posterior slope.

Hab. Duke of York Island, New Britain.

95. *PISON NITIDUS* Sm.

Pison nitidus Sm. Journ. Linn. Soc., Zool. iii. p. 160 (1858), ♀.

Nearest to *scabrum* Turn.

Hab. Aru (Wallace); Ké (Wallace).

96. *PISON CONSTRICTUM* Turn.

Pison morosus Sm. Journ. Linn. Soc., Zool. viii. p. 85 (1864), ♀ (nec Sm., 1856).

Pison constrictum Turn. Ann. & Mag. Nat. Hist. (8) ix. p. 201 (1912), ♂.

These are almost certainly sexes of one species. It is nearest to the Queensland species, *P. punctulatum* Kohl.

Hab. New Guinea (Wallace); Mysol (Wallace), Mimika River, New Guinea (Wollaston).

97. *PISON RECHINGERI* Kohl.

Pison rechingeri Kohl, Denkschr. Akad. Wiss. Wien, lxxxi. p. 309 (1908), ♀ ♂.

Differs from *hospes* and *constrictum* in the sculpture of the median segment and the better-defined frontal sulcus.

Hab. Upolu, Samoa (Rechinger); Tonga (ex coll. F. Smith).

98. *PISON HOSPES* Sm.

Pison hospes Smith, Journ. Linn. Soc., Zool. xiv. p. 676 (1879), ♀ ♂; Smith, Descr. New Spec. Hymen. p. 139 (1879), ♀ ♂.

Hab. Hawaii; Singapore (*Ridley*); Cocos Islands (*Wood Jones*).

Probably imported into Hawaii. It is doubtfully distinct from *P. pallidipalpis* Sm.

*New World Species.*99. *PISON LÆVIS* Sm.

Pison lævis Sm. Cat. Hym. B. M. iv. p. 317 (1856), ♀.

Hab. Georgia.

100. *PISON CONFORMIS* Sm.

Pison conformis Sm. Trans. Ent. Soc. London, p. 297 (1869), ♂.

Hab. Mexico.

*101. *PISON CRESSONI* Rohw.

Pison cressoni Rohw. Proc. U.S. National Mus. xl. p. 570 (1911).

Hab. Nicaragua.

*102. *PISON CAMERONII* Kohl.

Pison fasciatum Kohl, Verh. zool.-bot. Ges. Wien, xxxiii. p. 339 (1883), ♀ (nec Radoszkowski).

Pison cameronii Kohl, Verh. zool.-bot. Ges. Wien, xlvii. p. 546 (1893).

Hab. Mexico or Peru.

103. *PISON MACULIPENNIS* Sm.

Pison maculipennis Sm. Journ. of Entom. i. p. 80 (1860), ♀.

Hab. Para (*Bates*); Ega (*Bates*).

*104. *PISON PARAENSIS* Spin.

Pison paraensis Spin. Mem. Accad. Sc. Torino, (2) xiii. p. 58 (1851), (1853), ♀.

Hab. Lower Amazon.

*105. *PISON AUREOFACIALE* Strand.

Pison aureofaciale Strand, Zool. Jahrb. xxix. p. 174 (1910).

Hab. Paraguay.

*106. *PISON CONVEXIFRONS* Tasch.

Pison convexifrons Tasch. Zeitschr. f. d. Ges. Naturw. xxxvi. p. 18 (1870), ♀.

Hab. Rio de Janeiro.

107. *PISON CHILENSIS* Spin.

Pison chilensis Spinola, in Gay, Hist. fis. Chile, Zool. vi. p. 326 (1851).

Hab. Santiago; Coquimbo.

*108. *PISON AREOLATUS* Spin.

Pison areolatus Spinola, in Gay, Hist. fis. Chile, Zool. vi. p. 327 (1851), ♀.

Hab. Chile.

*109. *PISON VARIICORNIS* Reed.

Pison variicornis Reed, Anal. Univ. Chile, lxxxv. p. 22 (1894).

Hab. Chile.

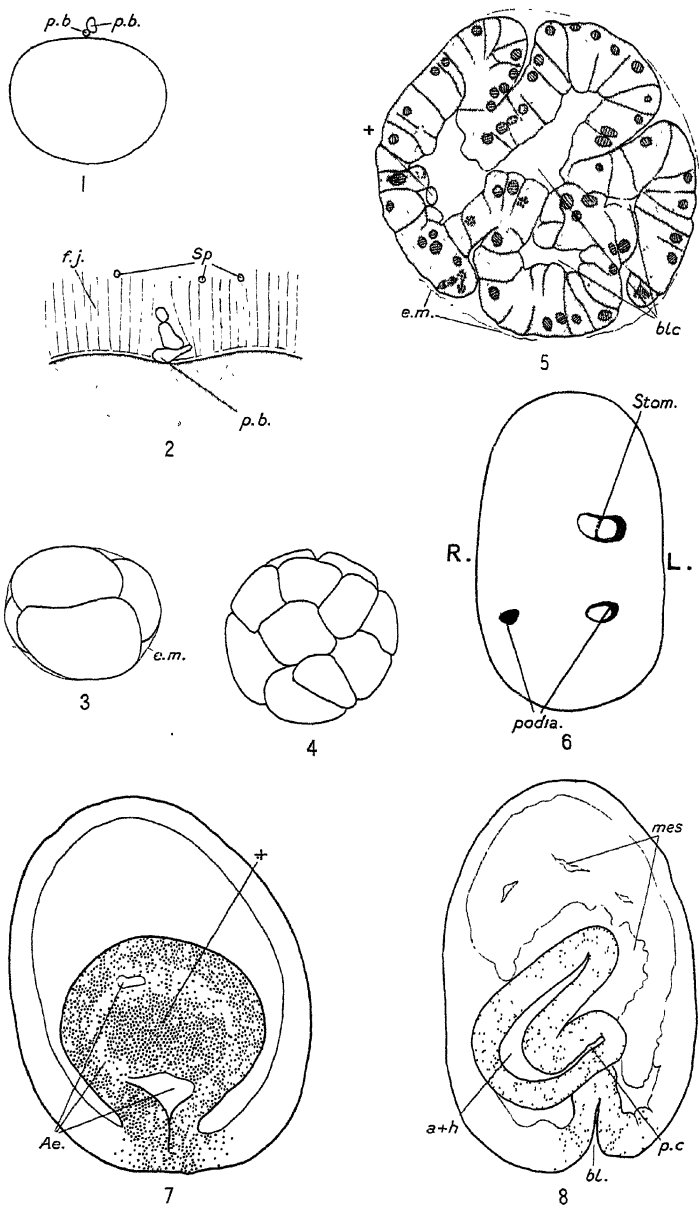
Pison latus Sm. and *Pison flavipictus* Sm., both collected by Bates on the Upper Amazon, belong, according to my determination, to the genus *Scapheutes* Handl., but the types appear to be lost or have not been marked. *Pison pilosus* Sm. belongs to the genus *Pisonopsis*. Smith evidently discovered his error as to the first two, for they are omitted from his list of the genus in 1869.

Genus *PISONOPSIS* Fox.

1. *P. CLYPEATA* Fox, Psyche, vi. p. 553 (1893), ♀ ♂. Nevada.
2. *P. TRIANGULARIS* Ashm. Ent. Mus. Philadelphia, x. p. 9 (1899). Colorado.
3. *P. BIRKMANNI* Rohw. Trans. American Entom. Soc. xxxv. p. 129 (1909). Texas.
4. *P. PILOSUS* Sm. Ann. & Mag. Nat. Hist. (4) xii. p. 295 (1873) (as *Pison pilosus*). Ega.
5. *P. ARGENTINUS* Schrottky, Ann. Soc. Argent. lxviii. p. 251 (1909). Catamarca.
6. *P. ANOMALA* Mantero, Bull. Soc. Ent. Ital. xxxiii. p. 202 (1901). Patagonia.

I have only seen *P. pilosus* Sm., and therefore can give no key to the species.

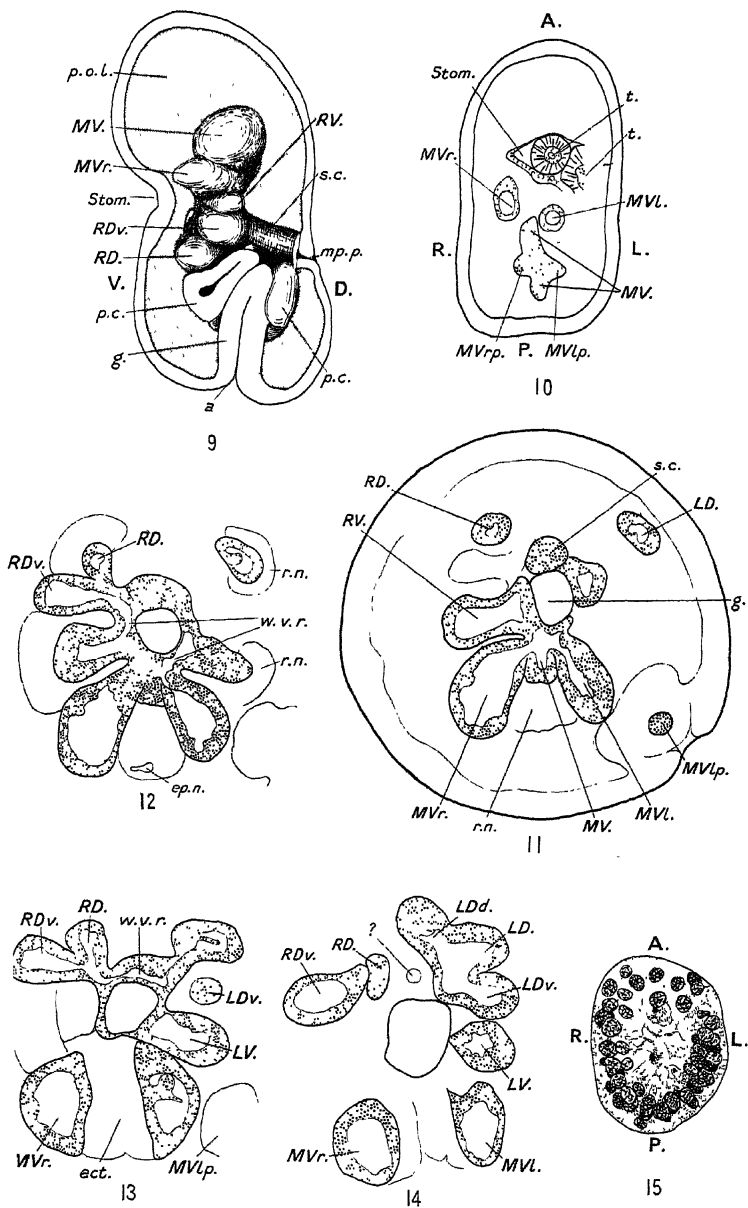
The genus is entirely American, and will probably prove to be nearly as rich in species on that continent as true *Pison*.



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DEVELOPMENT OF CUCUMARIA.



30. The Early Development of *Cucumaria*: Preliminary Account. By H. G. NEWTH, A.R.C.S., F.Z.S., Demonstrator of Zoology at the Imperial College of Science and Technology.

[Received May 31, 1916: Read October 24, 1916.]

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INTRODUCTION.

The study of the development of the various groups of Echinoderms has attracted many workers during recent years, and the result of their labours is a remarkably complete and, on the whole, remarkably consistent chapter of embryological research. Only in the case of the Holothurioidea has there been left any considerable hiatus in our knowledge of the normal development of a group. Undoubtedly many causes have contributed to this defect, but chiefly it is due, I think, to the difficulty of artificially fertilizing the eggs and raising cultures of the larvæ in the laboratory. The forms hitherto investigated have accordingly been investigated incompletely, or they have been viviparous, as in the case of *Synapta vivipara*, or they have been such as present a "shortened" larval life and can therefore be readily reared, as in the case of *Cucumaria*.

The main outlines of the development of the Auricularia are described in the works of Semon (12) and Bury (1 and 2), who both investigated the same species—*Synapta digitata*; and Clark (3) has given an admirable account of the embryology of *S. vivipara*. It has been urged, however, with much reason, that the synaptas are unsuitable forms to study, on account of the departure of their adult anatomy from the typical Holothurian plan. "The fact is that *Synapta* is about the worst form that could have been chosen to represent the Holothurioidea. Its radial water-vascular canals are only transitory larval structures, and its buccal tentacles not only spring directly from the water-vascular ring, but, in contravention of the rule which prevails in all the other groups of Holothurioidea, their number is no longer a multiple of five" (MacBride, 8). We owe to Ludwig the only fairly complete account of an ontogeny to which the above objection does not apply. His description of the development of

Cucumaria planici (7), published without figures, and purporting to be only the preliminary to a fully-illustrated memoir, has generally been accepted as correct; but in the absence of his completed work, which was never published, and in view of the interest of some of his results, it was desirable that a fresh study should be made. The suggestion that I should undertake this research and the opportunity to conduct it I owe entirely to Professor MacBride, whose encouragement and assistance I gratefully acknowledge.

My work on the embryology of *Cucumaria* had been in progress for nearly three years, and was still in many respects incomplete, when I learnt that Mr. H. Ohshima, *Rigakushi*, of Tokyo Imperial University, was engaged upon similar researches. In these circumstances the present short statement was prepared. No attempt will be made in what follows to give, even in outline, a picture of the whole period covered by my preparations; it must suffice to draw attention to those of my results which, on points of importance, either confirm or cast doubt upon the conclusions of Ludwig and others.

MATERIAL AND METHOD.

My material consisted at first of a series of stages in the development of *Cucumaria saxicola*, supplied by the Marine Biological Association to Prof. MacBride, who handed them to me for examination. I have since been able to add to this certain stages in the development of the nearly allied *C. normani*, adults of which species were sent to me in London. These animals spawned in my tanks, as I shall describe, and gave me the opportunity of observing the living larvæ and of bridging certain gaps in the original series. I may say at once that nothing can be seen, in the living young, of the internal changes that are occurring, and that both stocks of material were fixed in ignorance of the great rapidity with which the early development takes place*.

In view of the discrepancy between the statements made below and those of Ludwig, it should be noted that the fixative used by him was 50 per cent. alcohol followed by 70 per cent. alcohol. Of my own methods of preservation and sectioning I cannot treat in this place further than to say that the only reliable fixatives were found to be the picro-formol-acetic mixture of Bouin and Flemming's strong fluid (acting for not more than two hours), and that the method of double-embedding in celloidin and wax was always used. Special difficulties in orientation necessitated a modification of the latter method, and this I hope to describe at some length in my full account. Sections were generally cut 6 μ thick, and were stained with an alcoholic

* Since the above was written a consignment of *C. saxicola*, from Plymouth, has provided me with abundant material for a complete account of the development of that species. The description here given of spawning, segmentation, etc., in *C. normani* applies with equal truth to *C. saxicola*.

solution of hæmatein followed by orange-G as a plasma stain. The figures are all from camera-lucida outlines.

THE LIVING YOUNG.

Spawning in every case has occurred in the night, and generally near midnight. On the one occasion on which a successful culture resulted, males and females of *C. normani*, living together in the same tank, began to spawn within a few minutes of one another. In other cases isolated individuals of both sexes have spawned during the night; but I could never succeed in fertilizing the eggs so shed by adding sperm-suspension to the water in which they were. My remarks about the living larvæ refer to the above-mentioned culture.

The newly-shed eggs (Pl. I. fig. 1), taken from among the tentacles of the female, are undergoing, or have just completed, their second maturation division. They are flattened at the poles—especially at the animal pole, which tends to float uppermost—and enclosed in a striated follicular jelly from which the follicle-cells have been cast off. No definite micropyle can be made out, but the umbilicus of the follicle, situated at the animal pole of the egg, almost certainly has the function of a micropyle, since sperms are unable to penetrate the jelly. The polar bodies project into the umbilicus. I did not observe the entrance of the sperm into the egg. (Pl. I. fig. 2.)

In the segmentation which follows there is nothing of that ideal regularity that has been described in the case of the egg of *Synapta* *. The first two cleavage planes are usually meridional, and divide the egg into four equal blastomeres, which may then rearrange themselves in relation to the original egg-axis (Pl. I. fig. 3); but in some eggs the first two blastomeres do not divide simultaneously. The third cleavage is equatorial. Subsequent divisions, so far as I am able to discover, do not follow any orderly scheme. They result in the formation of a morula (Pl. I. fig. 4), which gives rise to a wrinkled blastula of the type first described by Masterman, in *Cribrella* (10), and, later, by Gemmill, in *Solaster* (5) and *Porania* (6). At this stage (Pl. I. fig. 5) the embryo acquires cilia, and soon after emerges from the egg-membrane and begins to rotate slowly at the bottom of the culture tank. Gastrulation is marked externally by the smoothing out of the superficial wrinkles, and by elongation of the larva. The fully-formed gastrula is more opaque at its anterior (pre-oral) end, and in swimming this end is always upwards. The larvæ now swim just below the surface of the water, and rotate slowly about their long axis—in a counter-clockwise direction as seen from above †. A constriction appears soon after this, in

* This irregularity is due, I think, in great part, to polyspermy and to unnatural conditions in the laboratory. In a few individuals of *C. sariccola* I have seen perfect symmetry of cleavage up to the 16-cell stage.

† The blastulae of *C. sariccola* rotate clockwise; but after gastrulation the direction of rotation is, in the majority, reversed. I have no note about the direction of rotation of the *C. normani* blastula.

many but not all of the larvæ, near the equator, and at the same time the stomodæum arises as a crescentic invagination at the junction of the opaque and the less opaque regions of the body (age=48 hours). The formation of the stomodæum proceeds by the extension backwards of the horns of the crescent, their ultimate fusion in a posterior lip, and the in-sinking of the enclosed area. From the orifice thus established the five primary oral tentacles, formed *pari passu* with the stomodæum, soon come to project. They are tipped with little hyaline excrescences, and can be entirely withdrawn into the stomodæum. (Pl. I. fig. 6.)

During the completion of the stomodæum the primary tube-feet make their appearance as two circular depressions in the ectoderm; and from this time onwards the asymmetry of the larva (comparable to that of the Auricularia "pupa") is manifest. The stomodæum lies, very obviously, to the left of the median ventral line as determined by the tube-feet, and of these latter the left is placed further forward than the right. It is interesting to note that Ludwig describes the *right* primary tube-foot of *C. planici* as being the more anterior of the two. Fig. 6, which is of the corresponding stage in *C. savicola*, shows the displacement of the stomodæum, but a less-than-average displacement of the podia.

No further external change, except growth of the tentacles and the tube-feet, occurs during the free-swimming life of the animal. The ciliation of its surface is uniform at every stage: there is no segregation of the cilia into bands as there is in the larva of *C. planici* (Selenka, 11). On the fourth and fifth days the larvæ still swim near the surface, but towards the end of the fifth day they tend to sink to the bottom and settle down upon their oral tentacles. Beyond this stage I shall not, at present, follow their development.

FORMATION AND SEGMENTATION OF THE COELOM.

The segmentation cavity appears during the formation of the wrinkled blastula from the solid morula. It is at first empty, *i. e.* it contains nothing that is coagulable by any of the usual fixatives—and no cell-communications exist, such as are required by Sedgwick's conception of the blastula as a syncytium. Mesenchyme and "blastocoel jelly" appear simultaneously later and seem to be identical, the processes of the cells merging indistinguishably, in sections, into the reticulations of the jelly, the interstices of which are filled with oil droplets. Since, however, this oily yolk uniformly fills the spacious blastocoel of later stages, it would seem that it must be contributed in part by cells other than those few which are found in it, and the fact, among others, that in the blastula there occur rounded, enucleate fragments of cytoplasm supports this view (fig. 5, +).

It was stated of *C. planici* by Ludwig, that mesenchyme and

ectoderm formed a single tissue, and this is observable in the later larval stages and the pentacula of *C. saucicola* and *C. normani*. Of these species up to the third day stage it is certainly not true, the ectoderm, except near the blastopore, being a definite, single-layered epithelium. My preparations do not confirm the same author's further statement that mesenchyme originates from the definitive ectoderm (except for the above-mentioned cytoplasmic fragments, and except in unhealthy or abnormal individuals).

The fully-formed gastrula is very remarkable (Pl. I. fig. 7). The archenteron is deeply invaginated and forms a flattened, thick-walled vesicle. In one lateral aspect (as made out from sections) this vesicle is almost circular; at right angles to this direction it is seen edgewise, and appears dumbbell-shaped in section owing to the central inflection of its flattened sides. Its cavity, in other words, is a disc with a thickened periphery except where this is interrupted by the blastopore. I have found this stage in both the species examined.

The details of the process by which the primary coelomic pouches are formed from the archenteron I am unable to give. What is certain, however, is that the water-vascular system, the posterior (perivisceral) coelom, and the gut are derived, in the order named, from successive regions of the archenteron, beginning at the anterior end. At the stage shown in fig. 8 the primary pouches are already present as thick-walled vesicles, still in connection with the gut and with one another. The large anterior pouch gives rise to the stone-canal and to the rest of the water-vascular system, and may therefore be supposed to represent anterior coelom *plus* hydrocoel. It is a flattened sac which crosses the larval axis obliquely and curves back to communicate with the posterior coelom. Nine sections on either side of the one figured show these two sacs in the same relative positions, but their connection with one another persists through only three sections in all, and the posterior coelom communicates with the gut in one section only—that next to the one figured.

Apparently this state of affairs has been brought about by an S-shaped bending of the whole of the archenteron at right angles to its plane of flattening, coupled with a pinching-off of its anterior three-quarters proceeding inwards from opposite edges of the original disc.

This stage I have seen in *C. normani* only.

There is no indication yet of the position either of the madreporic pore or of the stomodæum, and it is therefore impossible, in the absence of annectant stages, to determine with certainty the dorsal and ventral sides of the larva. It will be remembered that in *Synapta* the coelom is described by Selenka as being budded off dorsalwards from the archenteron, and a similar orientation has been ascribed to the primary vesicle in *C. planici* by the same author, and in *Holothuria floridana* by Edwards (4). Ludwig states, without giving the grounds for his opinion:

“Das Hydro-Enterocoel liegt nicht, wie Selenka angiebt,

anfänglich, d. h. so lange es noch mit dem Urdarme zusammenhängt, dorsalwärts von diesem um erst nach seiner Abschnürung an dessen linke Seite zu rücken, sondern befindet sich von vorn herein an dieser Seite."

By the middle of the third day the formation of the stomodæum has begun and the segmentation of the coelom, in *C. normani*, is complete, though in some larvæ the connection between hydrocoel and posterior coelom is not yet lost. The hydrocoel still points forward in the axis (roughly speaking) of the animal, and from it project on either side the rudiments of the radial canals and of the oral tentacles (Pl. II. fig. 9). The posterior part of the anterior vesicle is now bent, at an obtuse angle to the hydrocoel, towards the dorsal body-wall, and in many larvæ has acquired an opening to the exterior—the madreporic pore. There is only a very shallow invagination of ectoderm in the formation of the opening, and it will probably be correct to regard the whole of this postero-dorsal limb of the water-vascular system, which is later converted *en bloc* into the stone-canal, as being homologous with the anterior coelom of other Echinoderm larvæ (*cf.* Bury, 2). At this time—as also, more markedly, in the next stage—there is no continuous clear lumen in the hydrocoel, the stone-canal, or the posterior coelom, and it is doubtful, I think, whether the madreporic pore ever functions. Even after the tentacles are well established, and can be protruded and retracted, their lumen is obliterated in some places by the vacuolated inner ends of their cells.

The relation of the tentacle-rudiments to the undifferentiated residue of the hydrocoel is precisely similar to that of the rudimentary radial canals, with which they alternate. There is no association among any of the ten outgrowths to indicate their future arrangement with reference to the water-vascular ring. This is a stage obviously somewhat later than the most advanced three-days-old larva of *C. plani* described by Ludwig, in which the hydrocoel had the shape of an irregular horse-shoe, slight out-pushings of which were identified as the rudiments of the radial canals. In *C. normani* there is a complete suppression of the typical curved hydrocoel crescent, owing to the large size and close crowding together of its lobes, and to the thickness of their walls. On this account the interpretation of this stage is peculiarly difficult in the absence of intermediate stages between it and the one next following. My identification of the hydrocoel lobes in fig. 9 must therefore be considered as being provisional only, and it must be pointed out that it is based upon the determination of the point of closure of the ring-canal on the following day—which I have only made out in *C. saxicola*.

THE PENTACULA OF *C. saxicola*.

The third-day (65 hours) larva of *C. saxicola* shows a considerable advance upon the last stage described. The stomodæum

forms a spacious oral atrium into which the five tentacles project, and the ring-canal now surrounds the anterior end of the gut, its plane being inclined to the larval axis (as in *C. planei*) in such a way that its dorsal part is nearer the anterior end of the animal than its ventral. It is possible now to identify the radii and to determine the point of closure of the ring. In six of my preparations of this stage the ring is still open in the *left dorsal interradius*.

Radial canals and tentacles are given off alternately from the ring, but there is already discernible, in some individuals at any rate, the beginning of that curious grouping of tentacles which is found in the later pentacula. Of the radial canals the mid-ventral is much the largest. It projects directly backwards from the ring-canal, and has at its posterior end a rhombic dilatation the two laterally directed angles of which represent the internal rudiments of the primary tube-feet, which are thus, from their first appearance, not terminal (Pl. II, fig. 10). In *C. planei*, *C. kirchbergii*, *Holothuria tremula*, *Psolus fabricii*, and *Phyllophorus urna* the first two podia have been described, by various authors, as arising simultaneously from the posterior end of the mid-ventral radial canal, *Holothuria floridana* being exceptional, in that it forms at first a single terminal tube-foot on the mid-ventral canal (Edwards, 4).

The right and left dorsal radial canals project outwards in the plane of the ring-canal, and their ends have already begun to turn backwards; the lateral ventral canals are short, blunt, and unbent. There is no difference in the degree of development of the five tentacles. In those larvæ in which the ring-canal is closed a small blunt outgrowth—the rudiment of the Polian vesicle—has appeared on the posterior wall of the ring at the point of closure; but whether this belongs to the dorsal or to the ventral limb of the hydrocoel I find it impossible to determine.

The relations of the stone-canal are what they were in the last stage described. At about the middle of its length, however, there is now a slight enlargement of the lumen, caused by an up-pushing of its antero-dorsal wall. This marks the point at which the secondary madreporite (Madreporenblase of Ludwig) will later be formed.

On the fourth day (84 hours) the water-vascular system presents an interesting transition stage, in which the three more dorsal tentacles are connected with the radial canals from which they spring in the adult, while the two more ventral ones still retain their interradial communication with the ring-canal. As in *C. planei*, the left dorsal radial canal has appropriated two tentacles and the right dorsal canal only one—that which was developed in the right dorsal interradius. The two lateral ventral radial canals have no tentacles associated with them, those developed in the ventral interradii being appropriated later by the mid-ventral canal, to which, indeed, their bases already

begin to be approximated (Pl. II. fig. 11). What may be the mechanics of this migration of the bases of the tentacles from the ring to the radial canals I can only surmise. I conceive it to consist essentially in the conversion of those areas of the wall of the ring which immediately surround the bases of the radial canals into the walls of the canals themselves, which are growing rapidly at this time.

While a full discussion of the significance of these arrangements cannot be attempted in this place, it may be well to call attention to the fact that the speculations of Semon as to the phylogeny of Holothurians were in great part founded upon the assumption that the alternation of the tentacle lobes of the hydrocoel with the radial canals, observed in *Synapta*, was a constant feature of Holothurian ontogeny. This assumption was controverted by Ludwig, who, after examining an eight-day larva of *C. planci* as his earliest stage, had the assurance to assert that the tentacles arose from the radial canals and not from the ring. A careful perusal of the same author's second paper, in which earlier stages are described, makes it appear doubtful whether the first appearance of the tentacles was ever observed by him at all. The question therefore still remains to be solved: Which is secondary, the alternation of the tentacles (as lobes of the hydrocoel) with the radial canals, or the adult condition in which they are outgrowths of the radial canals?

Text-figure 1.

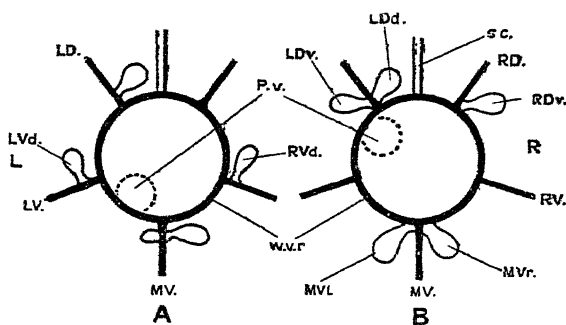


Diagram showing the relation of the various derivatives of the hydrocoel in (A) *Holothuria floridana* and (B) *Cucumaria*.

For explanation of lettering see p. 640.

A comparison of the arrangement of the primary tentacles in *Holothuria floridana*, according to the account of Edwards (4), with that in *Cucumaria* perhaps throws some light on this matter (text-fig. 1). In the development of that animal, as in *Cucumaria*, there is an asymmetrical disposition of the tentacles in relation

to the radii, but the disposition is totally different, and in addition the Polian vesicle is in the left *ventral* interradius. The two agree in one respect only: *the tentacles alternate with the radial canals*. Edwards did not attend, apparently, to the place of actual origin of the tentacles, and a clearing up of that point would be valuable.

The present paper, demonstrating, I believe, that there is a primary alternation of tentacles and radial canals in two species of *Cucumaria*, seems to support the assumption made by Semon, whose phylogenetic speculations, however, I am not concerned to defend.

The only other feature of the fourth-day larva to which I shall allude is the condition of the stone-canal. In the position where, on the third day, a slight dilatation was observed, there is now an area of the antero-dorsal wall of the canal in which the cells have become large and clear, the cells of the other walls of the canal remaining columnar and closely packed. The appearance of cross-sections through this region is now very characteristic (Pl. II. fig. 14) owing to the crowded, darkly-staining nuclei in the postero-ventral and lateral walls of the tube. Examination of later larvæ proves that we have in this swelling-up of certain cells of the stone-canal a preliminary stage in the thinning-out of the part affected to form the vesicle noticed by Bury (2), Ludwig (7), and MacBride (8 & 9), which is converted into the internal madreporite of the adult. It will be clear from my description of its mode of origin that Bury's view that this vesicle represented the anterior coelom is incorrect. It is, on the contrary, a secondary differentiation of the stone-canal. In this conclusion I agree with Ludwig.

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EXPLANATION OF THE PLATES.

Lettering.

A., anterior; a., anus; Ae., archenteron; a+h., anterior coelom *plus* hydrocoel; bl., blastopore; ble., blastocoel; D., dorsal; d. (following the abbreviation for a radial canal), tentacle projecting dorsalswards from the radial canal indicated; ect., ectoderm; e.m., egg-membrane; ep.n., epineural space; f.j., follicular jelly; g., gut; L., left; LD., left dorsal radial canal; LV., left ventral radial canal; mes., mesenchyme; mp.p., madreporic pore; MV., mid-ventral radial canal; MVL and MVR., primary tentacles developed to the left and right, respectively, of the MV. canal; MVlp. and MVrp., first pair of podia developed from the left and right sides, respectively, of the MV. canal; P., posterior; p.b., polar body; p.c., posterior coelom; p.o.l., præ-oral lobe; P.v., Polian vesicle; R., right; RD., right dorsal radial canal; r.n., radial nerve; RV., right ventral radial canal; s.c., stone-canal; Sp., spermatozoon; Stom., stomodæum (oral atrium); t., tentacle; V., ventral; v. (following the abbreviation for a radial canal), tentacle projecting ventralswards from the radial canal indicated; w.v.r., ring-canal of the water-vascular system.

PLATE I.

Fig. 1. *Cucumaria normani*. Unfertilized egg seen from the side.

2. *C. normani*. Animal pole of the same egg. Leitz. obj. 6, oc. 3.

3. *C. normani*. Four-cell stage.

4. *C. normani*. Early morula seen from above.

5. *C. normani*. Section through the wrinkled blastula, showing at + a cytoplasmic inclusion. Leitz obj. 6, oc. 3.

6. *C. saxicola*. Fourth-day larva, drawn from a preserved specimen. The tentacles are withdrawn within the stomodæum, and two of their tips only can be seen. Note the position of the stomodæum on the left side of the larva.

7. *C. normani*. Longitudinal (? coronal) section through the fully-formed gastrula. The cavity of the archenteron is encroached upon at * by the inflected middle part of one of its flattened walls.

8. *C. normani*. Longitudinal (? sagittal) section of a free-swimming larva 44 hours old, showing the first stage in the segmentation of the coelom.

PLATE II.

- Fig. 9. *C. normani*. Graphic reconstruction (by superposition of camera lucida outlines) of a larva on the middle of the third day, viewed from the left side. The reconstruction was arrested at the median plane in the case of the body-wall, the gut, the ventral horn of the posterior coelom, and in the neighbourhood of the madreporic pore, so that these are seen in section. The hydrocoel is seen in its outer aspect—i. e. its concavity is towards the right. The large anterior lobe is the mid-ventral canal.
10. *C. saxicola*. Coronal section of a fourth-day larva to show the relation of the rudiments of the primary podia to the mid-ventral canal. Note that the radial canal is solid at this stage.
- 11-14. *C. saxicola*. Four transverse sections through a fourth-day larva to show the relation of tentacles to radial canals. Figs. 11-13 are of consecutive sections; one section is missed between 13 and 14. The order of the sections is from the posterior to the anterior end of the larva.
15. *C. saxicola*. Coronal section through the stone-canal of the same larva as fig. 10. Leitz 2 mm. apochr. obj., comp. oc. 6.



31. Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Mammals and Birds in the Society's Gardens.—Part II.* By BRUCE F. CUMMINGS, British Museum (Natural History)†.

[Received August 4, 1916: Read November 21, 1916.]

(Text-figures 1–36.)

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STRUCTURE.		

Snodgrass (1), in 1899, pointed out certain broad features of divergence in the internal anatomy among the larger divisions of the Mallophaga, such as the Amblycera, the Ischnocera, and the family Trichodectidæ. Recently, Harrison (2) has claimed the existence of a large accessory sac of unknown function in connexion with the male reproductive organs as the chief and most reliable character for separating the family Boëpidæ from all other Mallophaga. In 1910 Mjöberg's sketches of the male reproductive system in several Mallophaga (6) offered the systematist an inducement to compare such organs as the vesicula seminalis, the ductus ejaculatorius, and the spermatheca, in order to discover the extent of their divergences in different species and genera. In the following paper some evidence on this subject is brought forward. So far from there being a monotonous uniformity in these internal organs, the differences are such as no student of these little parasites can afford to neglect. The ultimate systematic value of such characters can only be estimated after many more dissections; but whether it be great or small, the considerable difference in the form of the *vesicula* between the two Owl Philopteri—*Philopterus ccelebrachys* and *P. cursor*,—to take an example, is one which cannot be satisfactorily ignored and which conveniently falls within the province of the systematic writer to record.

Methods.

All chitinous parts were studied after hot caustic potash had cleared away the soft parts. For an examination of the soft

* Part I. appeared in the P. Z. S. 1916, p. 253.

† Published by permission of the Trustees and communicated by the SECRETARY. [Owing to the illness of Mr. Cummings, the final proofs of this paper have been corrected, and the magnifications of the figures worked out, by the Rev. James Waterston, B.D., B.Sc., of the Imperial Bureau of Entomology.—EDITOR.]

parts, fresh material was not available; but it was found that good results may be obtained with well-preserved spirit material if the specimens be plunged for a few minutes in caustic potash, to destroy the connective tissue, and then soaked for twelve hours in glacial acetic acid, transferred to absolute alcohol, dissected in oil of cloves, and mounted in Canada balsam.

For sectioning, the specimens had been fixed in Carnoy's solution (Formula No. II.), which proved, however, to be not very satisfactory. For imbedding, Awati's methods, detailed in the P. Z. S. for 1914 (p. 686), were followed, the sections being stained in the ordinary way with Ehrlich's Hæmatoxylin, Eosin, or Orange G. I am much indebted to Mr. C. A. Gunns for assistance in section-cutting.

[In none of the figures which follow of the male reproductive system and copulatory apparatus are the muscles shown, and in some the exact position of the entry of the *vas deferens* into the *ductus* is not given because, as a rule, in most of the dissections this could only be made out with the greatest difficulty on account of the delicacy of the *vas deferens*.]

Family PHILOPTERIDÆ.

THE OWL PHILOPTERI.

Piaget (3) grouped the Owl Philopteri together, under the general name "Strigicolæ." For convenience, this plan may still be followed. But these Owl parasites cannot very easily be separated off as generically distinct from the Philopteri of Birds of Prey, with which they show certain affinities. Within themselves they fall into three distinct types, as pointed out by Prof. V. L. Kellogg (4), represented by the following three species:—*P. rostratus* Nitzsch, *P. ceblebrachys* Nitzsch, and *P. cursor* Nitzsch.

The following four species were included in the collection:—

PHILOPTERUS ROSTRATUS Nitzsch (5, p. 76).

4 ♀ ♀, from the Barn-Owl, *Flammea flammea* (Linn.)*.

Dissections were made from male material kindly handed over to me by Mr. Waterston.

PHILOPTERUS CURSOR Nitzsch (5, p. 75).

Several specimens of both sexes, from *Bubo maculosus* (Vieill.) (S. Africa) and *B. ascalaphus* (Savign.) (Egypt). *P. cursor* has been further recorded from *B. capensis* Smith, *B. virginianus* (Gmel.), *Asio accipitrinus*, *A. wilsonianus* (Less.), and *A. galapagensis* (Gould).

* The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong. Boston, 1907, p. 44 (1912)).—EDITOR.]

PHILOPTERUS CEBLEBRACHYS Nitzsch (5, p. 77).

Many examples, male and female, from *Nyctea nyctea* (Linn.) and *Strix aluco* Linn. This very distinct round-headed species has been reported also from *Nyctala tengulmi* (Gmel.), *Surnia ulula* (Linn.), and others.

PHILOPTERUS ATHENE Mjöberg (6, p. 115).

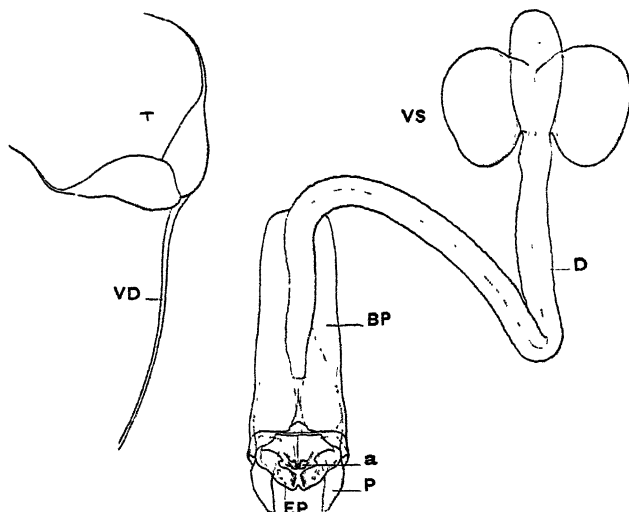
Many examples of both sexes, from *Athene noctua* (Scop.) (Cairo). Mjöberg's specimens came from *Athene glaucus* (Savign.). The British Museum possesses specimens presented by the Hon. N. C. Rothschild, and taken on an unidentified Owl in Abyssinia.

Male Reproductive System of Owl Philopteri.

Of the three species dissected—*P. cursor*, *P. ceblebrachys*, and *P. athene*, the vesiculæ of *P. cursor* and *P. athene* are somewhat alike, while that of *P. ceblebrachys* differs strongly from both:—

Philopterus cursor (text-fig. 1).—There are the usual two

Text-figure 1.



Philopterus cursor. Male reproductive system and copulatory apparatus. $\times 100$.

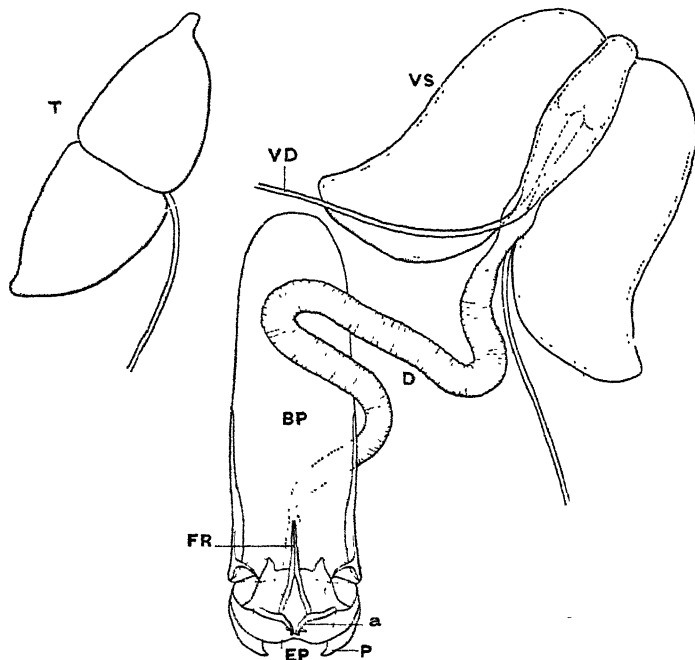
T. testis. VD. vas deferens. VS. vesicula seminalis. D. ductus. BP. basal plate. a. transverse piece. P. paramere. EP. endomeral plate.

pairs of testes, large pear-shaped organs, the round ends approximated and united by a commissure. The *vesicula seminalis* in a *Philopterus* of the *cursor* type, perhaps *P. nudipes* P. from *Asio* sp., is a large oval organ of much the same form

as that figured by Snodgrass (1, pl. xiii. figs. 7, 8, & 9) for *Colpocephalum flavescens* and *Eurymetopus taurus*. In *P. cursor*, on account of the swelling out and rounding of the two separate sacs of which the *vesicula* is composed, it approximates to the form of the *vesicula* in *P. ceblebrachys* (text-fig. 2). Note the relatively small size.

Philopterus ceblebrachys (text-fig. 2).—In outline the *vesicula*

Text-figure 2.



Philopterus ceblebrachys. Male reproductive system and copulatory apparatus. $\times 100$.

T, testis. VS, Vesicula seminalis. VD, vas deferens. D, ductus. BP, basal plate. FR, forked rod. a, transverse piece. P, paramere. EP, endomeral plate.

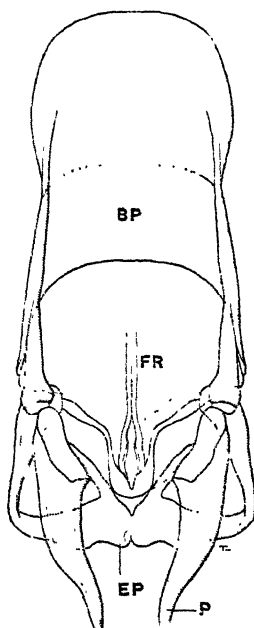
resembles Minerva's helmet. In between the rounded posterior "horns," which sweep backwards and outwards, the *ductus* enters and swells out at once into an oval form.

Male Copulatory Apparatus of the Owl Philopteri.

Philopterus rostratus (text-fig. 3).—Distinguished by the unusually long parameres in proportion to the basal plate, a

feature which separates the species from all other Owl Philopteri so far examined. *Basal plate*: Rather short, broad; lateral margins strongly chitinised along posterior half. The hind margin juts out medially into a prominence beneath the endomeral plate. *Parameres*: Elongate rounded rods, graduated to a slender distal end, and slightly curving inwards towards one another. *Endomeral plate*: Quadrilateral, as broad as the basal plate to which it is attached, and about half the length of the parameres. The endomeral plate has a marginal band which

Text-figure 3.



Philopterus rostratus. Male copulatory apparatus. $\times 200$.

BP, basal plate. FR, forked rod. EP, endomeral plate. P, paramere.

along the lower side deepens considerably in the middle part, where it bends upwards between the parameres and sends backwards across the plate two diverging splints. Each of these runs halfway along the oblique base-line of the articular surface of the paramere. The forked rod (see text-fig. 1) is homologous with similar parts in *P. cursor*, *P. ceblebrachys*, and *P. athene* (see text-figs. 1-3).

Philopterus cursor (text-fig. 1).—*Basal plate*: Compared with parameres this is very long indeed, fairly broad, the lateral margins divergent from in front posteriorly. *Parameres*: Short, inwardly curved, flattened, with acute tips. *Endomerai plate*: This runs out between the parameres into a broad rounded apex. There is a median longitudinal groove and a transverse groove cutting the former at halfway, dividing the plate into four sections of the shape seen in the figure. Under a high power there are visible on these areas eight white spots, probably representing the alveoli of minute sensory hairs. There are three of these in each posterior area and one in each anterior area. The forked rod is thinly chitinized, but recognizable. The two small nodular swellings at "a" are ridged and densely chitinized, and may be homologous with the parts similarly lettered in *P. ceblebrachys* and in *P. asturinus* with the penis.

Philopterus ceblebrachys (text-fig. 2).—*Basal plate*: About four times as long as the parameres. The posterior half is broader than the anterior half, and possesses strongly chitinized, parallel, lateral margins. *Parameres*: Quite short, stout, slightly incurved. *Endomerai plate*: Broad behind, nearly as long as parameres. Posterior lateral angles rounded. A narrow band runs along posterior margin. Lateral margins straight, convergent anteriorly. Anterior margin short, straight, each anterior lateral angle produced into an outwardly curved process. Forked rod well developed, the handle of the fork incompletely fused, indicating its originally double nature. The transverse piece is homologous with the part similarly shaped in *P. athene*.

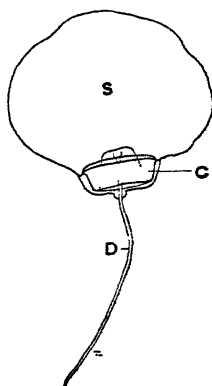
Philopterus athene.—This resembles the apparatus of *P. ceblebrachys*. In length of the head this species recalls *P. rostratus*; in the form of the *vesicula seminalis* it approximates to *P. cursor*, but the vesicula of *P. rostratus* I have not yet been able to examine. *Basal plate* and *Parameres*: As in *P. ceblebrachys*. *Endomerai plate*: As in *P. ceblebrachys*, except for the concave posterior margin. "Forked rod": Represented by two rods converging posteriorly. *The transverse piece*: This is obviously homologous with the part so named in *P. ceblebrachys*, but each half is concave and not straight.

The Mouth-parts of Philopterus ceblebrachys.—*Lyriform organ*: Anterior cornua short and broad; posterior cornua absent. *Labium*: A labial sclerite is present, as in *Trichodectes gastrodes* Cummings (7, p. 99) and in *Goniodes falcicornis* Nitzsch (Part I. p. 287); its posterior cornu on each side curves outwards and stops at the base of the "paraglossa"; the transverse bar is short and situated far forward, near the front margin of the labium; anterior cornua absent.

The Receptaculum seminis.

Philopterus ceblebrachys (text-fig. 4).—Piaget (3, p. 30), in describing this species, says:—"A la face ventrale deux bandes longitudinales sur les côtés de la valvule qui est peu visible, et deux taches arquées dos à dos, avec un petit cercle de chitine en avant." As Mjöberg points out (6, p. 256), this "petit cercle de chitine," figured by Piaget in several species, is not a superficial character of the exoskeleton, but a part of the receptaculum seminis strongly chitinised and showing through the integument. The receptaculum consists of a small more or less circular sac of soft delicate tissue carried by a dark-brown thickly-chitinised *calyx* at the end of a fine duct leading into the genital chamber.

Text-figure 4.

*Philopterus ceblebrachys*. Receptaculum seminis. $\times 100$.

S. sac. C. calyx. D. duct.

Mjöberg calls this a "kreisrunde Chitinscheibe," and figures it in *Nirmus lineolatus* just as if it, indeed, were a flat circular disc on one side of the base of the sac. In *P. ceblebrachys* the calyx is a saucer-shaped piece of chitin with a rim. The duct enters through the centre of its membranous bottom and debouches at the tip of a large chitinous cone, which overtops the side of the calyx and at its base is continuous with the calyx, so that in optical section it looks as if the bottom has been pushed clean through the centre.

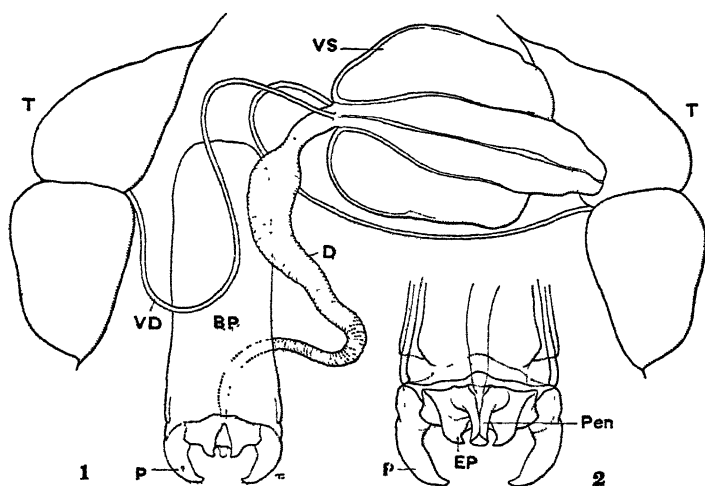
In an Owl *Philopterus* of the *cursor* type, from *Asio otus*, the *calyx* differs from that in the preceding in several respects. The outer surface is closely striated in a more or less longitudinal direction, the constriction below the rim is deeper, and the "cone" is parallel-sided at its upper end and has a truncate broad top.

The text-figure should be compared with those of *Ibidacus* and *Neophilopterus* (p. 672). Relatively, the *calyx* in the *Philopterus* species is much wider across and shallower, and the chitin is of an entirely different consistency, being dark brown, rather thin, but very firm.

THE PHILOPTERI OF BIRDS OF PREY.

Future research may bring the Philopteri of the Owls and the Birds of Prey into closer relationship—a result which, according to modern views on the classification of birds, would lend no support to the theory that the phylogeny of total obligate

Text-figure 5.



Philopterus asturinus. Male reproductive system and copulatory apparatus.

1. ventral, $\times 100$; 2. dorsal, $\times 150$.

T. testis. VS. vesicula seminalis. VD. vas deferens. BP. basal plate. D. ductus.
P. paramere. EP. endomeral plate. Pen. penis.

parasites like Anoplura and Mallophaga will assist in the unravelling of the phylogeny of their hosts, as ornithologists present a solid front against the old position of the Owls among the Birds of Prey. Between the two groups there is a strong likeness, for example, in the male copulatory apparatus.

PHILOPTERUS PLATYSTOMUS Nitzsch (5, p. 69).

Females and larvæ from *Buteo erythronotus* (King) (Argentina).

PHILOPTERUS PICTUS Giebel (5, p. 68).

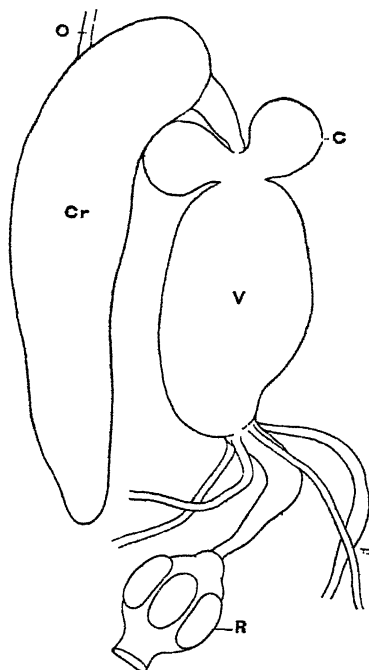
1 ♂ & 1 ♀ from *Aquila chrysaëtos* (Linn.).

PHILOPTERUS ASTURINUS Mjöberg (6, p. 112).

Males and females rather plentifully from the Goshawk (*Astur palumbarius* (Linn.)).

This species comes close to Denny's type-specimens of *P. nisi* from *Accipiter nisus* (Linn.), which Piaget—I do not know with how much reason—synonymises with *P. gonorhynchus*.

Text-figure 6.



Philopterus asturinus. Alimentary canal. $\times 70$.

O. oesophagus. C. caecum. Cr. crop. V. ventriculus. R. rectal glands.

Male Reproductive System and Copulatory Apparatus (text-fig. 5).

—Testes and vas deferens as usual. The *vesicula seminalis* is a little elongate, of the shape given in the figure. *Basal plate*: Short and broad, lateral margins well chitinised along whole length, slightly convergent in front. *Parameres*: Short, stout, curved, very much as in the Owl *Philopteri* (except *P. rostratus*). *Mesosome*: Ventrally, running out from the posterior margin of

basal plate, is a short stout penis-like tube formed of two distinct longitudinal halves. Each half is densely chitinated and dark brown in colour, and at the base spreads out towards the base of the paramere. This tube is perhaps homologous with the transverse piece of *P. ceclebrachys* and other Owl Philopteri (see text-figs. 1 & 2). The *endomerall plate* corresponding with the same piece in the Owl Philopteri overlies the rest of the mesosome and bridges across from the base of one paramere to the other. The *ductus ejaculatorius* runs in *under* the bridge. The endomerall plate may either consist of two pieces superimposed upon one another—viz., the deeply bifid band marked in the text-figure and the plate above this stretching across from paramere to paramere; or these parts may only be sculpturing or local thickenings in the same plate of chitin.

Alimentary Canal (text-fig. 6).—This belongs to the common Ischnoceran type figured by Snodgrass (1, pl. xi. fig. 11). But the crop is longer and narrower, and in the ventriculus immediately behind the two anterior cæca there is a deep constriction, below which the *ventriculus* is broad and spacious.

THE PHILOPTERI OF DUCKS, GEESE, AND SWANS.

This interesting group of Mallophaga was first seriously tackled by Giebel in the 'Insecta Epizoa,' 1874 (5, pp. 113–116), in which eight distinct species are described, including the typical *Philopterus icterodes*. Denny (8, pp. 95 & 99) described two other species—*P. cygni* from *Cygnus bewicki* Yarr. and *P. chrysophthalmi* from *Glaucion clangula* (Linn.) (*Clangula chrysophthalmi*). By reference to Denny's collection, now in the British Museum, his "*D. chrysophthalmi*" proves to be an Accipitrine parasite, probably *P. pictus*, a straggler perhaps upon the Golden-eye Duck; or Denny may have misread or confused his label, mistaking "Golden-eye" for "Golden Eagle." Giebel remarks, of the form figured and described by Denny under the name "*D. icterodes*," that "seine Abbildung giebt so erhebliche Differenzen an, dass man gerechte Zweifel an der Identität erheben könnte." I have examined Denny's specimens, and find, as Giebel suspected, that Denny did not have *P. icterodes* before him. His specimens belong to the form which, until the types of Giebel and Nitzsch can be re-examined, I propose to identify with Giebel's *P. ferrugineus*. Piaget (3, pp. 113–116) was imperfectly acquainted with these Duck parasites. He describes and figures true *P. icterodes*, I think correctly, although the sketch of the terminal segments of the abdomen of the male (pl. x. fig. 1 a) appears to show the remarkable structure on the endomerall plate described below and called the effractor, which is present in *P. ferrugineus* but absent in *P. icterodes*. Piaget did not know any of Giebel's species, and subsequent authors have labelled all Philopteri from Geese and Ducks *P. icterodes*.

Through the generosity of Mr. Waterston I have been able to prepare, dissect, and mount a considerable number of Philopteri of this group from a variety of hosts, the following distinct species emerging as a result:—*Philopterus cygni* D. (on Swans), *P. brunneiceps* G. (on Geese), *P. icterodes* N. (on different species of Ducks), *P. ferrugineus* G. (on Ducks), *P. obtusus* G. (on *Somateria mollissima* (Linn.)), and a species taken on the Pochard, which I cannot name satisfactorily and must therefore regard as new.

The whole group, for which the new genus *Anatæcus* is proposed, is a remarkably compact one, and the species comprised in it are all closely related and sometimes with difficulty differentiated one from another; so that Giebel's specific diagnoses are of little assistance, even for the purposes of identification. Further, as straggling occurs so frequently from Duck to Duck, it is unsafe to rely for help upon the host's name.

The above identifications, therefore, must be accepted with reserve. Rather than give new names, it has appeared better to perpetuate the old where that was possible, at the same time figuring the parts important for the differentiation of the species. In the future, should the types of Giebel and of Nitzsch become accessible, these decisions can be revised if necessary.

ANATÆCUS, gen. nov.

Head distinguished by the characteristic alation of the clypeus, by the presence of two small peg-like spines dorsally (one on each side of the posterior apex of the signatural plate*), by the unusually short antennæ, and the modified lyriform organ. Abdomen characterised by the form of the lateral tergites, which in segment 1 meet each other in the middle line. In subsequent sections, except the last, the tergites leave an uncovered median field. In the male copulatory apparatus, the fusion of the parameres distally with the pseudopenis, the form of the latter, the endomerale plate, and sac are also good generic characters. Finally, the form of the *vesicula seminalis* and the extremely short *ductus* must be included.

Small ectoparasites, infesting Swans, Geese, and Ducks.

A genus indicating in the male genitalia certain Lipenroid affinities, and in the mouth-parts obvious affinities with the genus *Ibidæcus*, nov.

Genotype: *Anatæcus icterodes* Nitzsch.

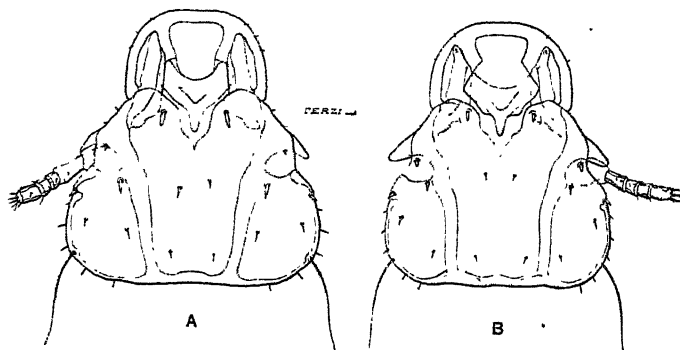
The six species distinguished up to the present (no doubt others remain to be elucidated) fall into two groups, according as the *effractor*—a remarkable structure shaped like a tin-opener—is present or absent on the endomerale plate of the male. A. Those with the "tin-opener" are *A. ferrugineus* and *A. obtusus*. B. Those without it are *A. cygni*, *A. icterodes*, *A. brunneiceps*, and *A. difficilis*, sp. n.

* The whole of the dorsal chaetotaxy of the head is a generic character.

In the same genus should be included *Docophorus brunneopygus* Mjöberg (6. p. 130) on *Anser leucopsis*, which I do not know.

A. difficilis, sp. n., closely resembles *A. ferrugineus* in form, with the one considerable difference that the "tin-opener" is absent.

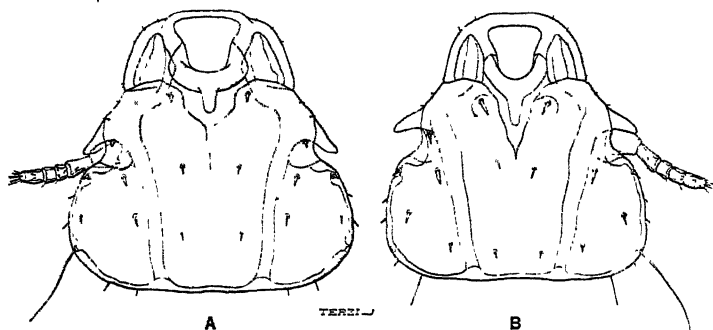
Text-figure 7.



A. *Anataeus ferrugineus*, ♂. B. *A. icterodes*, ♂. $\times 80$.

Compare the signatures.

Text-figure 8.

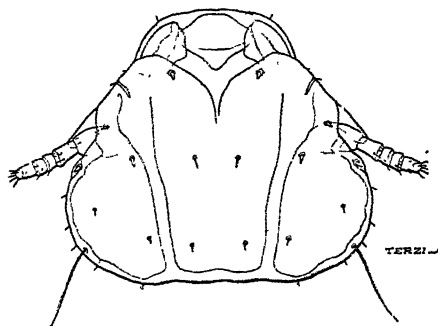


A. *Anataeus obtusus*, ♂. B. *A. brunneiceps*, ♂. $\times 80$.

Compare the signatures.

Text-figs. 7, 8, & 9 illustrate the form of the head in these species, and the table presents a comparison of the head-measurements (millimetre scale). In the table the measurements taken are from the posterior apex of the signature to the anterior margin, and transversely from one lateral margin to the other at the level of the base of the clypeal bands, together with the total length and the greatest breadth.

Text-figure 9.

*Anatecus cygni*, ♂. × 80.Head-measurements (millimetre scale) of Males of
Anatecus species.

	Group A.						Group B.					
	<i>A. ferrugineus.</i>			<i>A. obtusus.</i>			<i>A. cygni.</i>		<i>A. icterodes.</i>		<i>A. brunneiceps.</i>	
	1.	2.	3.	1.	2.	3.	1.	2.	1.	2.	1.	2.
Breadth	·40	·41	·40	·46	·46	·45	·49	·50	·38	·38	·42	·40
Breadth in front	·20	·20	·19	·25	·24	·25	·22	·20	·22	·23	·18	·20
Length	·41	·43	·40	·46	·45	·45	·41	·40	·41	·41	·43	·41
Length in front	·19	·19	·19	·18	·16	·17	·10	·10	·16	·16	·14	·14

In addition to the differences in the form of the head, in the cephalic index, and in the male copulatory apparatus, small specific characters may also be seen in the colour (rather variable, however), in the shape of the abdomen, and the genital mark in the male.

The Society's Collection contained two or three specimens of the typical *A. icterodes*.

ANATECUS ICTERODES Nitzsch. From *Aex galericulata* (Linn.).

The Mouth-parts. (Text-fig. 10.)

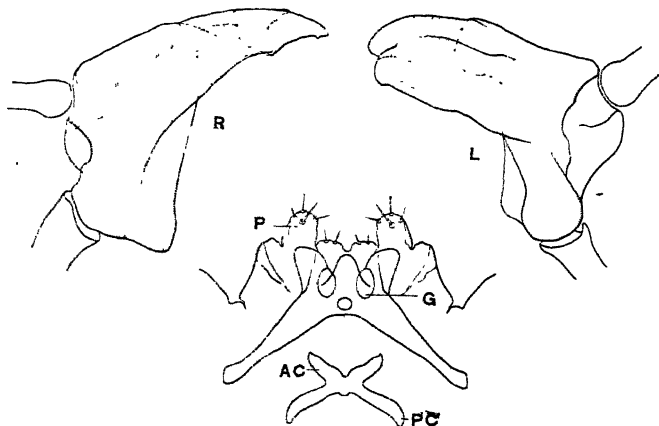
Mandibles.—In *A. cygni* and *A. icterodes*, and probably throughout the genus, the narrow basal process of the left and the quadrangular process at the base of the right mandible are absent, the shape of the mandibles being accordingly different.

These processes occur and have been described in many species of Mallophaga, both Amblycera and Ischnocera (see Part I. and some of Kellogg's figures. Proc. Cal. Acad. Sci. vol. vi., 1896). I find them absent not only in *Anataëcus*, but in the genus *Ibidæcus*, nov. (see p. 664) and in *Boöpia tarsata*—probably absent in other Boöpidæ as well.

The lyriform organ and "glands" are modified throughout the genus, and resemble those of *Ibidæcus* figured on p. 670. The text-figure shows their typical form.

A. icterodes.—Both *mandibles* are very similar, the right differing from the left in the acuteness of the apices of its two branches. In the right there is a minute protuberance subapically on the ventral branch and another lower down on the cutting-edge. There are a few transverse ridges distally on the

Text-figure 10.



Anataëcus icterodes. Mouth-parts. $\times 400$. Maxillary lobes not shown.

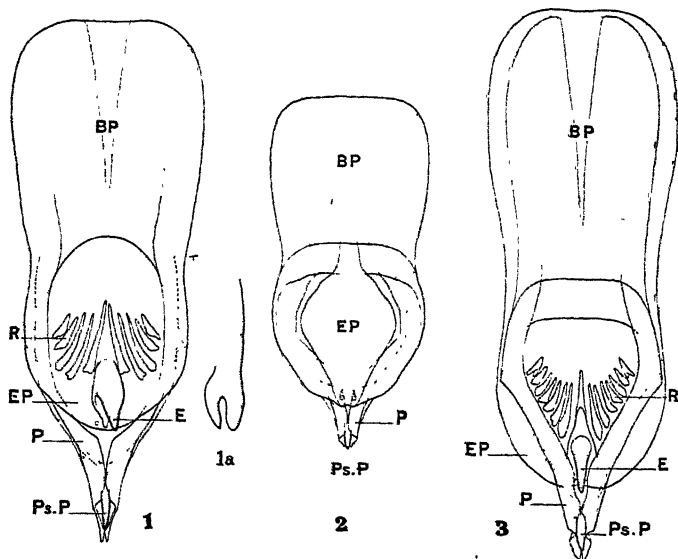
R. right, and L. left mandibles. P. "paraglossa." AC. anterior cornu, and PC. posterior cornu of lyriform organ. G. "gland."

dorsal surface of the dorsal branch and a V-shaped groove, the lower margin of which curves inwards and then downwards, showing a notch in its margin just before the latter slopes inwards in a straight line. *Labium*: This has clearly demarcated lateral margins, formed of stronger chitin than the immediately surrounding area. "Paraglossæ" short, with long terminal spines. Inner pair of lobes well defined. *Iso-pogometric apparatus*: The two sprawling posterior cornua of the lyriform organ run in a dorsal direction, one on each side of the pharynx. The anterior cornua are two short broad processes, rounded in front. The lyriform organ is small and thinly

chitinised, invisible without dissection. *The basal pieces (or "glands")* are small circular areas, each framed in a chitinous plate which goes forward to the labial margin as anterior hypopharynx. Posteriorly are attached the usual narrow tendons, one to each "gland." "Ducts" or chitinous chords apparently absent.

A. cygni.—In the form of the mandibles, lyriform organ, basal pieces, anterior hypopharynx, and in the absence of ducts this species agrees closely with the preceding, and I am unable to find any obvious differences. The mandibles are perhaps more powerful.

Text-figure 11.

Male copulatory apparatus of the genus *Anataecus*. $\times 150$.

1. *A. ferrugineus*. 2. *A. cygni*. 3. *A. obtusus*.

BP, basal plate. R, retinacular comb. EP, endomerale plate. P, paramere.

Ps.P, pseudopenis. E, effractor. 1a, side view of effractor.

The small sac cannot be shown.

The Male Copulatory Apparatus in the Genus Anataecus.
(Text-figs. 11 & 12.)

Group A. Those with the effractor.

A. ferrugineus.—*Basal plate*: Longer than broad, with a rather deep and broad V-shaped white mark debouching on the anterior margin, looking like a split, the result of an accident in dissection;

it is present in all the species except *A. cygni*. The plate and parameres are fused in one piece, there being no articulation and no trace even of a suture. *Parameres*: Distally these appendages bend in to meet one another and embrace the median pseudopenis, which is probably endomerale. The parameres are fused with the base of the pseudopenis, but not with one another, the tips being quite discrete. Parameres and pseudopenis lie dorsally and curve upwards at the end. Below, in the mesosomal space, is the *sac*—an interesting structure, slightly expansible (in copulation), and carrying dorsally at its distal end a great number of minute finger-shaped papillæ. Behind these are seen numbers of minute circular spines. On its ventral surface in the hypomerale area is a remarkable retinacular apparatus, consisting of a semicircular row (with the apices pointing backwards) of ten elongate powerful teeth, those in the middle as long as the pseudopenis; it is uncertain whether this comb of teeth can be moved forward or not. Below the sac is the *endomerale plate*, which, like the parameres, is continuous with the basal plate. Fixed upon the posterior margin dorsally is the densely chitinous effractor. It is a little, more or less oval piece of dark-brown shiny chitin, running out into two limbs behind—a dorsal and a ventral, the one immediately above the other. The ventral limb is blunt at its tip, the dorsal more acute, the two together recalling a tin-opener without the handle.

A. obtusus.—Very similar to the apparatus of the preceding species, so that it is sufficient to signal the differences. The basal plate is different in shape in the neighbourhood of the effractor; the teeth of the retinacular comb are shorter and more numerous, being fifteen or sixteen or more in number; and, lastly, the effractor has a different shape, being distinguished by the narrower and more elongate dorsal limb, which is set in the ventral process of pyriform outline as in a sort of pedestal.

Group B. Those *without* the effractor. Correlated with its complete absence, is the complete absence of the retinacular comb.

A. cygni.—*Basal plate*: Short and broad, posterior V-shaped mark absent. *Parameres*: Broad at the base, at the apex blunt and fused closely with the pseudopenis, which is quite short. Two minute white circles on the posterior margin of the endomerale plate—probably the relatively large alveoli of minute sensory hairs.

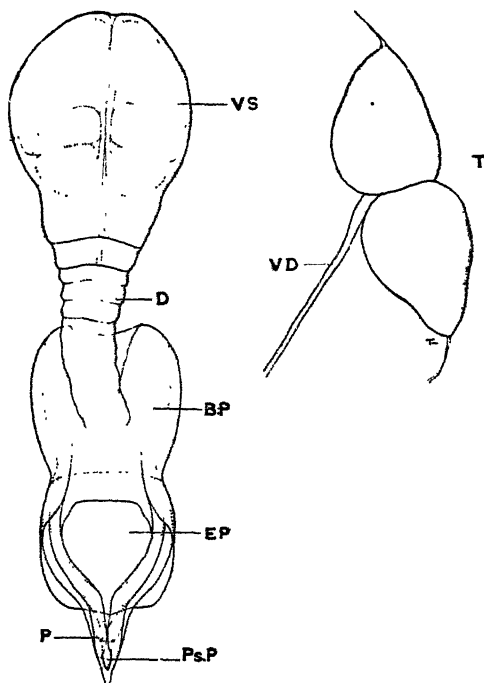
A. icterodes.—*Basal plate*: Short and broad; the V-shaped mark present. *Parameres*: Longer than the basal plate, and enclosing a space of different shape from that of *A. brunneiceps*, with which it must be compared.

A. brunneiceps.—In this species the apparatus, very similar to

the preceding, is nevertheless characterised by the possession of an elongate, thin, chitinous splint lying dorsally on the sac and projecting a little beyond it. This probably is the penis, and is particularly easy to see in some specimens from *Somateria mollissima* *.

A. difficilis, sp. n.—The penis-splint is present. The apparatus appears to me to be quite indistinguishable from the preceding.

Text-figure 12.



Anataeus icterodes. Male reproductive system and copulatory apparatus.
× 160.

VS, vesicula seminalis. D, ductus. BP, basal plate. EP, endomerale plate.
P, paramere. Ps.P, pseudopenis. T, testis. VD, vas deferens.

Sac not shown.

Male Reproductive System in Anataeus. (Text-fig. 12.)

This was examined in *A. icterodes* and *A. brunneiceps* and found to be the same. It is noteworthy for the extremely

* It may exist in other species and yet escape detection, if the chitin be hyaline and transparent.

short ejaculatory duct, the large testes, and the curious locular character of the *vesicula seminalis*, which, as usual, consists of a right and a left ventricle fused into an organ of the shape seen in the text-figure.

THE PHILOPTERI OF STORKS AND IBISES.

Two new genera are diagnosed below—the one represented by *Philopterus tricolor* N. and found upon the Ciconiidae, and the other represented by *P. plataleæ* D. and found upon the Ibiidae. These two genera stand fairly close to one another. *Ibidæcus*, gen. nov., contains the species designated “Bisignati” by Piaget and characterised by the large double signature; *Neophilopterus*, gen. nov., contains the forms which Piaget collected under the heading “Setosi,” and is characterised by the fusion of the double signature into one plate. Other well-defined characters are recounted under the respective diagnoses of these two genera.

NEOPHILOPTERUS, gen. nov.

Head, especially in the female, relatively small; on the dorsal surface of the pre-antennal area, a transverse suture marks the posterior margin of the signature. In the new genus *Ibidæcus* each element of the double signature ends behind in an acute angle. In the present genus two acute angles are present posteriorly, suggesting fusion of an originally double plate*. Each of these posterior angles is situated more laterally than in *Ibidæcus*, and the plate on each side extends further, so as to overlie the clypeal band so prominent in *Ibidæcus*. By focussing down, the clypeal band is seen crossing the suture and thus uniting the clypeal region with the skull (as in other *Philopteri*). Thorax longer than broad, with a strong, transverse, acetabular bar running in from each side between the first and second pairs of legs and giving attachment to the former. Clavicles present. Abdomen with two transverse rows of silky hairs on the tergum of each segment. Two tergites on each segment situated laterally and leaving a bare median field except in the terminal segment, where they meet across the middle. The male copulatory apparatus is also fairly characteristic, and may probably prove diagnostic for the whole genus.

Genotype: *N. tricolor* Nitzsch (5, p. 96).

Parasites of the Ciconiidae.

The following good species can with certainty be referred to this genus:—*N. tricolor* N., *N. indicus* P., *N. incompletus* N., *N. unifasciatus* P. and *N. episcopi* Kellogg.

NEOPHILOPTERUS INCOMPLETUS Nitzsch (5, p. 97).

This is the only member of the new genus included in the

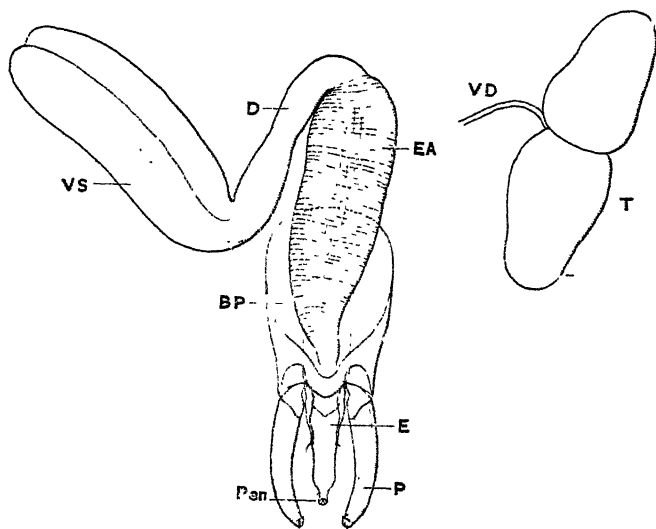
* I have no evidence to show that *Neophilopterus* is a derivative of *Ibidæcus*. Evolution, therefore, may have gone the other way.

collection. It was represented by many specimens from *Euxenura maquari* (Gmel.).

Giebel described a *Neophilopterus* from this same host, calling it *N. subincompletus*. But to this species, so far as it is possible to understand it from Giebel's description, the present specimens do not belong.

Male Reproductive System (text-fig. 13).—Testes pyriform as usual. The ductus is short, there being only two bends in it from the mesosome to the vesicula. The *vesicula seminalis* is elongate, narrow, with a longitudinal median groove indicating the double origin of this organ. The ductus, on leaving it, bends backwards for a little way, and for this portion of its length the duct is a fairly narrow canal. On turning forwards again after the second bend, it expands into a large canal quite

Text-figure 13.



Neophilopterus incompletus. Male reproductive system and copulatory apparatus. $\times 100$.

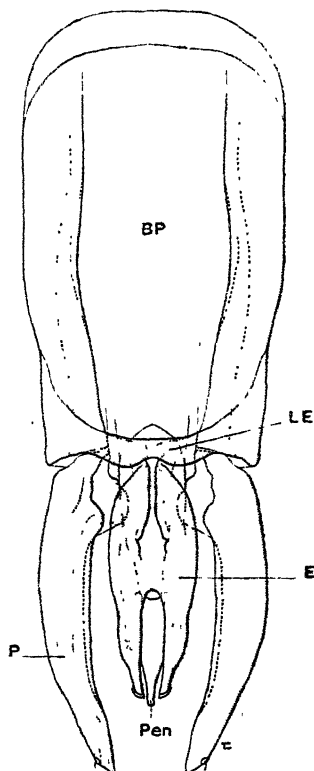
VS. vesicula seminalis. D. ductus. EA. ejaculatory ampulla. BP. basal plate. E. endomere. Pen. penis. P. paramere. T. testis. VD. vas deferens.

as broad and long as the *vesicula* itself, and no doubt functioning as an ejaculatory ampulla, as its walls are well supplied with transverse muscle-fibres, which run in from opposite sides and appear to become plaited together in the middle.

Male Copulatory Apparatus (text-fig. 13).—*Basal plate*: Longer than the parameres, broader behind than in front, posterior margin very convex. Each lateral margin has a broad band. Between

these lateral bands the median area of the plate is trough-shaped. Just behind the mesosome lies a small median plate, which sends off a branch on each side behind into each lateral region of the basal plate. *Parameres*: Quite evenly rounded rods, tapering somewhat towards the distal end and curving slightly inwards. *Mesosome*: Fused into one piece, shaped as in text-fig. 16. Half-way down on each side, projecting in a forward direction, is

Text-figure 14.



Neophilopterus tricolor. Male copulatory apparatus. $\times 140$.

BP, basal plate. LE, lower endomere. E, endomere. P, paramere.
Pen, penis.

a strong bristle set in a well-marked alveolus. These two bristles mark the end of the endomerale portion of the mesosome; between it and the distal half or telomerale portion a distinct suture can be observed. In the dissection of a new species of the genus collected on *Carphibis spinicollis* (Jameson) the endomerale

or proximal half of the mesosome is large; the two forwardly-directed spines are present, one on each side at its posterior end; while the distal or telomer half, strongly chitinised, is telescoped up within the endomer. Similarly with another new species from *Abdimia abdimii* (Licht.).

Comparison with the Apparatus of Neophilopterus tricolor (text-fig. 14).—This apparatus, while resembling the preceding in its basal plate and parameres, differs from each of the three forms mentioned above in features of the mesosome and in the presence of a small process or plate at the base of the mesosome which I regard as an upper endomer chitinisation. The part marked *Pen.*, apparently telomer, is white and more or less membranous, and appears to be held by the basal endomer portion shaped something like a pair of pincers.

The Receptaculum Seminis of the Female of N. incompletus (text-fig. 21 (3), p. 672).—This should be compared with the *receptaculum* of *Ibidæcus* (text-fig. 21 (1 & 2)). From a minute opening into the genital cavity, a delicate narrow duct runs up to a large semicircular sac borne upon a short circular calyx, brown in colour, with its rounded outer surface longitudinally striate.

Mouth-parts of N. tricolor and N. incompletus.—It is worthy of record that, while the lyriform organ and basal pieces of *N. incompletus* are normal, in *N. tricolor* the same parts are greatly modified. The lyriform organ resembles that of *Ibidæcus plataleæ*. Reference to the isolated modification of the isopogometric apparatus in species of certain genera is referred to in Part I. of this paper (p. 273), and is again discussed further on, where the genus *Ibidæcus* is discussed.

IBIDÆCUS, gen. nov.

Head with a double signature, consisting of two oblong plates, each plate usually with a small embossed area on the posterior end, which runs out into an angle. Clypeal bands very well marked; behind, they pass beneath each signatural plate and inwards to be attached to the skull. Antennæ long, with an especially long second segment. Abdomen large, broad, with a lateral tergite on each side of each segment, so as to leave a clear median area. A single row of hairs across the tergum of each segment.

Genotype: *Ibidæcus plataleæ* Denny (8, p. 100).

The type of Denny's species is in the British Museum.

The following species can certainly be referred to the new genus:—*I. hians* G., *I. bisignatus* N., *I. longiclypeatus* Piaget, and *I. bimaculatus* Mjöb.

The collection of the British Museum contains several undescribed species, including one from that interesting South-American bird, *Aramus scolopaceus*.

Neophilopterus and *Ibidæcus* appear to be related rather closely.

IBIDÆCUS PLATALEÆ Denny.

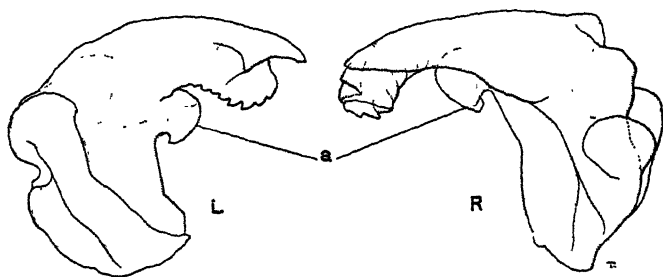
A single female among some *Colpocephalum* material from *Ibis molucca* Cuv. (*I. strictipennis*)—a straggler, probably, as *I. platealeæ* parasitises *Platalea leucorodia* Linn. The observations which follow were made on specimens kindly lent by Mr. Waterston.

Male Reproductive System.—This closely resembles that of *I. flavus*, sp. n., about to be described. The elongate form of the *resicula* may prove to be a generic character.

Through lack of material, the male copulatory apparatus cannot be satisfactorily described here.

Mouth-parts.—The modified isopogometric apparatus was described and figured in 1913 (9, p. 135, text-fig. 27) for this species under the name *Docophorus sphenophorus*. The *mandibles* are very interesting on account of their large size, the absence of basal processes in each mandible, and the unusual development of the curious process shaped like a bird's head on the cutting-edge halfway up between the tip and the base of each mandible (see text-fig. 15). The mandibles of the genus *Ibidæcus* resemble

Text-figure 15.

*Ibidæcus platealeæ*. Mandibles. $\times 180$.

L. left. R. right. a. avicularian process.

closely those of the genus *Anataæcus* not only in the avicularian process, in the absence of basal process and quadrangular process, but in the distal extremities consisting each of two apices with one ridged. The species *I. platealeæ* is distinguished by the size and prominence of the avicularian process* and in the large size of the ridges, which in side view give the tip of the mandible longitudinally a serrate appearance. When dissected out and placed face downwards on its cutting surface, the mandible is found to be as deep dorso-ventrally as it is long from base to apex.

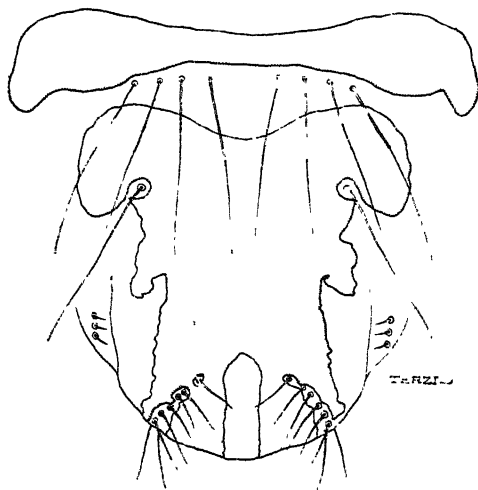
* Cf. avicularia in the Polyzca.

IBIDÆCUS FLAVUS, sp. n.

This species does not form part of the collection on which the report is based, but for the purpose of comparison it is useful to include it here, especially as many specimens—male, female, and larvæ—are available for study, being part of a valuable consignment of Mallophaga presented to the British Museum by the Hon. N. C. Rothschild.

I. flavus was collected on *Platibis flavipes* (Gould) (the Yellow-billed Spoonbill of Australia) from "Serpentine, Melbourne," on August 3rd, 1911, the label being endorsed "A. Coles." It is a handsome yellow parasite, recognisable by the shape of the pre-antennal region of the head, which is longer than in *I. plataleor* and more truncate at the front margin, but not so long as in *I. hians* and the other members of the long-headed section of the genus. The male genital plate is also a ready means of identifying this form (text-fig. 16).

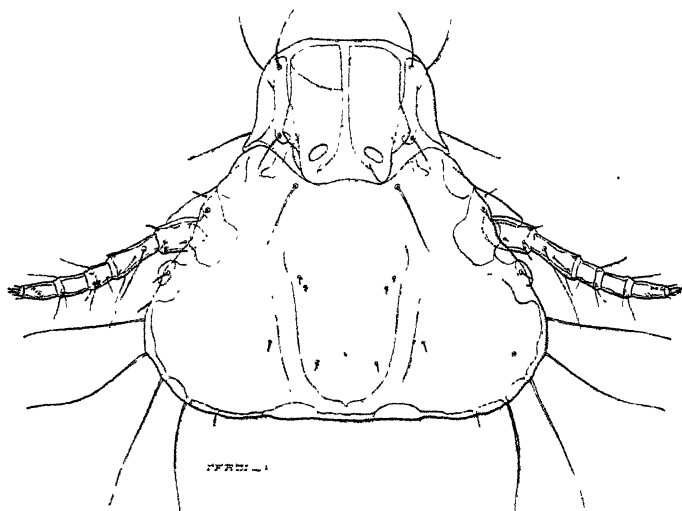
Text-figure 16.

*Ibidæcus flavus*. Male genital mark. $\times 90$.

External form.—**MALE.** *Head* (text-fig. 17): Large; pre-antennal region elongate, each signatural plate long, parallel-sided. Line of the temple from the antenna to the anterior lateral angle of the pronotum very convex. Occipital line straight, an exoccipital thickening on each side. Two dark brown, slightly diverging rafters run across the roof of the skull. A small gular plate present, in front gracefully narrowing to an acute apex. A single median occipital apodeme running into the prothorax. Tentorium absent. *Thorax*: Much narrower than the head, almost parallel-sided and rectangular. Spiracle opens laterally

just beneath the posterior lateral angle. Clavicles present, each running as a narrow rod from halfway down the lateral margin inwards and downwards to project beyond the hind margin into the metathorax as a broad band, which curves down and then forwards again to be inserted into the transverse acetabular bar behind the first pair of coxæ. The nota of both segments are divided by a median longitudinal colourless line. *Abdomen*: Regularly ovate. The terminal tergite forms a deep semicircular band around the genital opening. Ventrally, the genital plate with its chaetotaxy forms an easily recognisable mark (see text-fig. 16).

Text-figure 17.

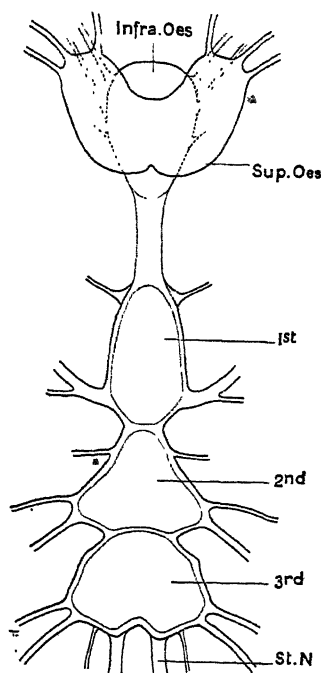
*Ibiæus flavus*. Head of male.

External form.—FEMALE. As in the male, except for the usual sexual differences of the abdomen.

Chaetotaxy.—For differentiating species, the chaetotaxy in this genus probably will prove of little value, as it is almost identical in the male and female both of this species and of *I. plataleæ* (except for the usual sexual differences at the end of the abdomen). For example, on the second segment of the antenna there is one elongate bristle and a shorter one beside it; the signatal plates are bare dorsally: on the ventral surface is a single bristle in the middle of each plate. On the clypeal band at the base there is one bristle dorsally, one projecting laterally, and one on the ventral surface. At the distal end of the band there are three more bristles similarly arranged. In both sexes of both species, also, there is a bristle on the dorsal surface of the skull just

behind the posterior acute angle of each signatural plate, a spine on the corneal surface of each eye, and a spiny hair behind and the same minute spines dotted sparsely over the postantennal dorsal area*. The chaetotaxy of the abdomen calls for no special mention.

Text-figure 18.

*Ibidacus flavus*. Central nervous system.

Infra.Oes. infra-oesophageal ganglion. *Sup.Oes.* supra-oesophageal ganglion.
1st, 2nd, 3rd. thoracic ganglia. *St.N.* stomatogastric nerves.

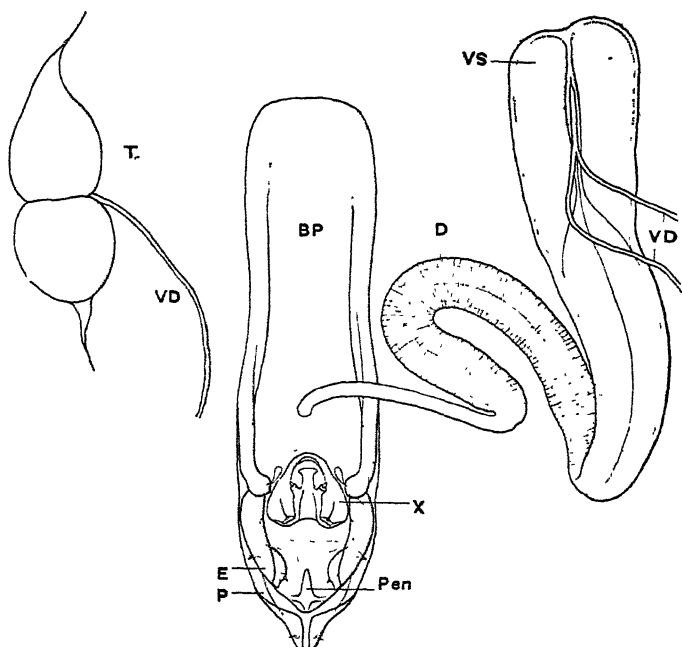
Alimentary Canal.—Mr. Waterston has pointed out to me some minute teeth on the chitinous lining of the pharynx in a *Læmobothrion*. Similar pharyngeal teeth in *Lipeurus ferox* were figured without comment in 1913 (9, p. 131, text-fig. 24). I now find similar teeth in the pharynx of other genera, including the present species, in which they are very minute and occur in small rows, each tooth directed backwards. The patch of teeth in the anterior cæcum of the crop is present in its usual extent; and the

* It is likely that the chaetotaxy, at least of the head, just as in *Anatæcus*, will prove to conform to the same plan throughout the whole genus. It is the same in two other species (unnamed) which I have examined, making four in all.

rest of the alimentary tract requires no detailed description, except perhaps a reference to the swollen base of each Malpighian tube.

Nervous System (text-fig. 18).—The state of preservation forbade any satisfactory dissection of the nervous system. The brain and main ganglia have been figured by Snodgrass for *Eurymetopus taurus* (1, pl. xvi. fig. 7). From this, the central nervous system differs in its general form. The supra-oesophageal ganglion is

Text-figure 19.



Ibiæcus flavus. Male reproductive system and copulatory apparatus. $\times 90$.

T. testis. VD. vas deferens. BP. basal plate. E. endomere. P. paramere.
Pen. penis. D. ductus. VS. vesicula seminalis.

much broader and the bay in front less deep. The sub-oesophageal is narrower; the first thoracic ganglion is also long and narrow and a little narrower in front than behind. The second or mesothoracic ganglion is roughly triangular in shape, the apex pointing forward. The metathoracic is the largest of the three, and more or less circular in shape. Behind, two extraordinarily large stomato-gastric nerves come off and supply the viscera.

Male Reproductive System (text-fig. 19).—*Testes*: Relatively

small, the commissure between them weak, so that in dissection the two are commonly separated *. *Vesicula seminalis*: This is a long narrow sac, with the usual longitudinal median division. The anterior end is a little truncate, broader than it is behind, where it decreases almost to the bore of the issuing ductus. *Ejaculatory ampulla* absent or only slightly developed.

Male Copulatory Apparatus (text-fig. 19).—*Basal plate*: Lateral margins well chitinated, parallel-sided except for the posterior third of their length, where the plate broadens out. Posterior margin concave. *Parameres*: At the base these are broad, thin, and transparent bands which fold in around the stout densely chitinous endomeres. Distally, the parameres curve in towards one another, so as to embrace the tip of the remarkable penis. Beyond the end of the penis they are produced forwards and become more strongly chitinous and brown in colour. Sub-apically, on the outside margin of each, there is a small directive hair. *Endomeres*: These remarkable appendages are much shorter than the parameres, strongly chitinated, deep brown in colour, and slightly curved, the convex side of the curve being on the outside of their length. The distal end is enlarged and displays two large ridges, forming distinct cutting-edges, each ridge with a separate apex. Between the distal ends lies the main body of the penis. At the base they articulate with almost the whole articular surface of the posterior lateral angles of the basal plate. *Mesosome*: The penis is a large bulky piece of chitin, the form of which is delineated in the text-figure. Behind it lies the curiously-shaped piece labelled X. This is clearly endomeral—whether upper or lower. I am not prepared to say. The outline of the central portion of this piece is shaped something like a bowl on a pedestal. There are two long backwardly projecting spines, one on each of the two outwardly curving cornua: and behind, on each lateral angle at the base of the bowl, a short peg-like spine.

Measurements (millimetre-scale).

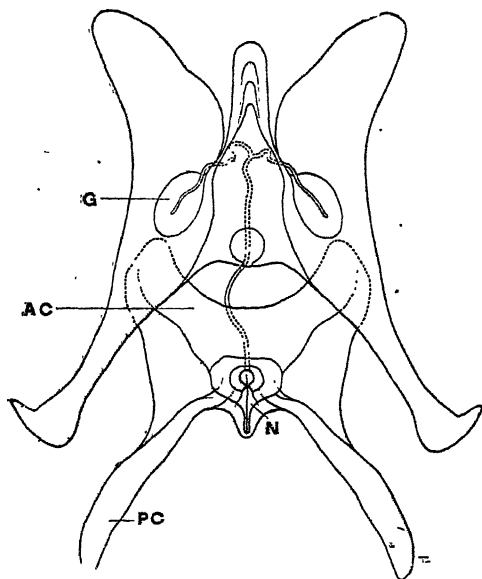
	Length.		Greatest Breadth.		Length of Antenna.		
	♂.	♀.	♂.	♀.	Segment.	♂.	♀.
Head . . .	·965	·96	1·00	1·16	1.	·09	·10
Pro- } thorax . .	·60	·80	{ ·65	·74	2.	·14	·17
Meta- }			{ ·80	1·05	3.	·08	·07
Abdomen . . .	1·28	2·20	1·30	1·85	4.	·08	·08
					5.	·085	·08
Total . . .	2·845	3·96			Total . . .	·495	·51

* Perhaps due to the condition of the tissues.

The Mouth-parts in the Genus Ibidacus. (Text-fig. 20.)

It is necessary to revert once more to the subject of the pharyngeal sclerite (or lyriform organ) referred to on p. 273 of Part I. and on p. 656 of the present instalment, inasmuch as within this single genus *Ibidacus* may be found species with these organs modified (as they occur in scattered instances throughout the Order), at least one species in which the parts are normal as in most Mallophaga, and in the species *I. flavus* a valuable intermediate stage.

Text-figure 20

*Ibidacus flavus.* Isopogometric apparatus. $\times 290$.

G. "gland." AC. anterior cornu, PC. posterior cornu, and N. "nucleus" of the lyriform organ.

This isopogometric apparatus, as Armenante (10) called it (on the theory that it was a contrivance for measuring the barbules into equal lengths for cutting)*, was supposed by Snodgrass (1) to be absent in some Mallophaga, such as *Leemobothrion*, *Ancistrana*, *Nit-schia*, *Physoctomum*, *Trinoton*, and others. In

* The fact that a similar apparatus is present in the Psocidae, which do not feed on feathers, does not necessarily disprove Armenante's theory, as its present function may be a new one, involving the adaptation of old parts. It is certainly difficult to believe that the so-called "glands" (now apparently wholly chitinous) were not once glandular, which they may still be in part.

1913 (9) I described them as present though modified in these five genera (and in others) and figured them, at the same time expressing the opinion that the apparatus was probably present throughout the Mallophaga. Up to the present, after many more dissections, there is no reason for changing this opinion. Recently (11, p. 393) Mr. Harrison has stated that the lyriform organ is "totally absent" in *Ornithobius*. But it is still present in this genus, though atrophied and very difficult to dissect out.

Although in such genera as *Læmobothrion*, *Menopon*, and *Colpocephalum* the apparatus shows differences in the lengths of the posterior and anterior cornua (often to a very great extent) and in the shape of the "glands," the characteristic form of lyriform organ and "glands" is preserved and is immediately recognisable. In the following Amblycera forms, however, very extensive modifications have been brought about:—*Boöpiu* and *Heterodoxus* (and probably the whole of the family Boöpidæ), *Gyropus* (probably all the Gyropidæ), *Pseudomenopon*, *Nitzschia*, *Trinoton*, *Tetrophthalmus* (belonging to the Menoponidæ), *Physostomum*, *Trimenopon*, *Ancistrana*. Among the Ischnocera, the following genera must be included:—*Ornithobius*, *Anatacus*, most of the genus *Ibidacus* probably, and the species *Trichodectes hemitragi* Cummings and *Neophilopterus tricolor*. Other forms, such as *Philopterus pertusus*, are indicated by Snodgrass, but these require investigation.

Modification proceeds by way of the gradual disappearance of the "nucleus" or rounded central portion of the lyriform organ, the reduction of the "gland" in size and its ultimate disappearance, and the transformation of "duct" and "glands" into hypopharyngeal sclerites. In text-fig. 20 is shown the lyriform organ of *Ibidacus flavus* modified, but with the still persistent remains of the "nucleus," consisting of a clear "pin-hole" surrounded by a circle of dense chitin. After bifurcating, each branch of the "duct" enters a small, delicate, oval "gland," which lies rather loosely encircled within a plate of chitin; this, behind, tails out in a narrow strip, and in front runs forward as a broad hypopharyngeal plate in outline shaped like a human thumb bent outwards with the "ball" of the thumb facing the corresponding structure on the opposite side. Between these two plates longitudinally runs a narrow chitinous strip, just as in *Lipeurus ferax* and others. A sheet of transparent chitin crosses between the two "glands," and in the centre of this may be seen a small circular clear space, possibly a hole.

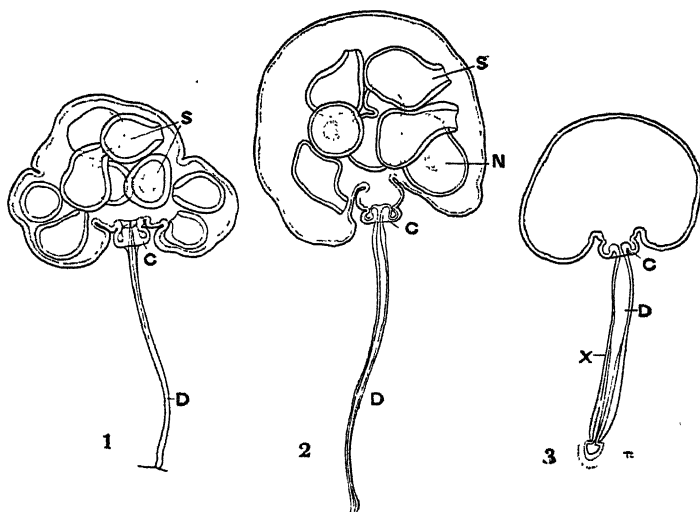
As compared with this apparatus, that of *I. platalea* is decidedly more modified, all sign of "nucleus" having disappeared; while in a species from *Aranus scolopaceus*, apparently undescribed, it is quite normal as in the majority of Mallophaga*.

* Mr. Harrison informs me that he possesses a species of *Ibidacus* from an Australian host with a normal lyriform organ.

Spermatophores in Ibiæcus. (Text-fig. 21.)

Ibiæcus plataleæ.—The *receptaculum seminis* is an irregularly shaped sac at the end of an extremely fine chitinous duct which opens by a small aperture through the chitinous intima of the genital chamber. The duct is finer than in *Neophilopterus incompletus* and the calyx is of a very different shape, being bent back around the top of the duct. Inside the sac may be seen the spermatophores—hard, thick-walled follicles containing nests of spermatozoa. In some of these no opening could be discovered.

Text-figure 21.



Receptaculum seminis of 1. *Ibiæcus plataleæ*, 2. *I. flavus*, and 3. *Neophilopterus incompletus*. $\times 70$.

S. spermatodome. C. calyx. D. duct. N. nest of spermatozoa.

Ibiæcus flavus.—The *receptaculum* resembles that of *I. plataleæ* and gives the same suggestion of a hydroid on its stalk. Just within the calyx, however, the canal opens into an atrium, absent in the preceding species. The flask-shaped spermatophores, five in one female and eight in another, lying loose and disposed irregularly, somewhat recall the form of the spermatophore figured by Von Siebold (13) for the Locustid *Decticus verrucivorus*, but the mouth is much larger and the neck broader. In each spermatophore in the first specimen was a nest of spermatozoa. In the second they were absent and had probably been discharged.

Cholodkovsky (14 and 15) divides the spermatophores in insects into four distinct types—(1) True spermatophores arising from the sexual organs of the male and facilitating the transference of

spermatozoa into the female organs. Outside the Insecta this is the typical spermatophore well known by zoologists to occur in Urodeles, Cephalopods, Decapods, Myriapods, and elsewhere. Among insects true spermatophores are possessed by *Grillus* (16), *Dytiscus marginalis* (17), and others. (2) Spermatodosen or structures which arise in the female sexual organs and serve "zur Dosierung des Samens bei der Befruchtung der abzulegenden Eier." To this group belong the flask- and retort-shaped bodies in the *receptaculum seminis* of many Locustids, where they were first discovered so long ago as 1791 by Gabriel Brunelli (18), and first accurately described by Carl T. von Siebold in 1845 (13) in *Decticus verrucivorus*. To this category belong also the spermatophore-shaped structures discovered by Cholodkovsky in Trichoptera (19) and the "spermatophores" of certain Lepidoptera. (3) Spermatophragmen, or masses of gland secretion, serving as a medium for the transference of the spermatozoa from the male to the female, for the maintenance of the spermatozoa during copulation, or for the closing up of the female genital opening. Examples: some Locustid females and the "Sackchen" of *Parnassius*. (4) Spermatodesmen* or bundles of spermatozoa united to form feather-shaped structures, and so on.

The so-called spermatophores of the Mallophaga are *spermatodose*, and were discovered in *Lipeurus jejunus* by Kramer in 1869 (12), in a valuable and careful memoir which has since been neglected by writers on the Mallophaga as well as by Cholodkovsky, Ballowitz, Blunck, and others engaged in the study of insect spermatophores. Kramer noticed a number of flask-shaped vessels lying loose in the *receptaculum seminis* of the female, and as they were too large to permit of their passage up the narrow chitinous duct, Kramer concluded that they arose within the *receptaculum*, and claimed to have detected the necks of half-formed flasks in a special layer of epithelial cells within the *receptaculum*.

Cholodkovsky's summary of the reasons for thinking that these interesting spermatodose arise within the female is very suggestive, and it is to be hoped that the problem may be satisfactorily elucidated by an examination of further parasites from the Zoological Gardens, well fixed and carefully preserved.

Rather than be classed under the general term *spermatophore*, the three new terms introduced by Cholodkovsky should be used in contradistinction to it, spermatozeugma being substituted for spermatodesmen.

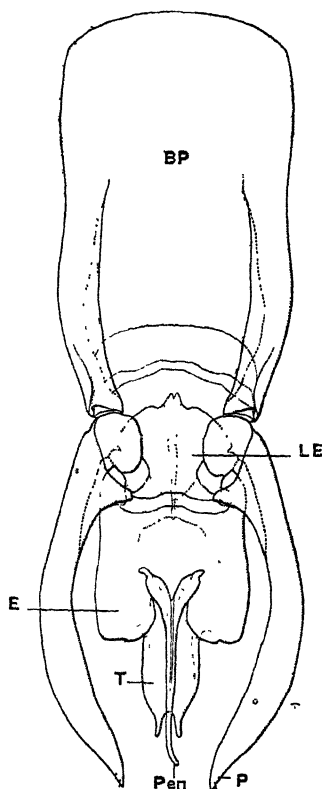
THE PHILOPTERI OF NUMENIUS.

Henry Denny, who, with Nitzsch and Giebel, shares the honour of laying the foundations of our knowledge of the Mallophaga, describes in his remarkable Monograph of British Lice, published in 1840, two species of *Philopterus* from the Curlew (*Numenius arquata* (Linn.)), viz. *P. testudinarius* and *P. humeralis*. In

* This is the spermatozeugma of Ballowitz (20).

'Les Pédiculines' (1880, p. 83), Piaget allows *P. testudinarius* to stand, and after stating that he does not know *D. humeralis* D., goes on to say "je n'ai jamais rencontré sur cet oiseau que le *testudinarius* dont je joins ici la description." The types of these two species, now in the British Museum, prove them to be perfectly distinct. Both species occur commonly on *both* the Curlew (*Numenius arquata*) and the Whimbrel (*N. phaeopus*); the characters of *P. testudinarius* are divergent from the rest of its allies and necessitate the constitution of a new genus.

Text-figure 22.



Philopterus humeralis. Male copulatory apparatus. $\times 120$.

BP. basal plate. LE. lower endomere. E. endomere. T. telomere. Pen. penis.
P. paramere.

PHILOPTERUS HUMERALIS D. (8, p. 88). (Text-fig. 22.)

One ♂ from *Numenius arquata* (Linn.).

Male Copulatory Apparatus.—*Basal plate*: The anterior half

is brown, flat. The posterior half possesses well-marked lateral margins, with a transverse band across the base. *Parameres*: Elongate curved rods, in cross-section circular. At its base each paramere possesses a large circular condyle which is turned inwards like the head of the femur in man. In front it is articulated with the posterior lateral angles of the basal plate, and behind, it lends a surface for attachment to the mesosome. *Mesosome*: The upper endomere consists of two square "wings"; each "wing" has a straight outer lateral margin and a characteristic "nick" in the posterior margin, after which the margin curves inwards and backwards towards the forked base of the elongate penis. The lower endomere is a small plate lying between the condyles of the parameres. Under the penis is a median elongate piece, bifid at the tip, representing telomer al chitinisations.

DOLLABELLA, gen. nov.

The diagnostic characters are few, but sufficient. They are the shape of the head taken in conjunction with the tergites of the abdomen, which in both sexes stretch right across and are on each side fused with the pleurites. Philopterids living with *P. humeralis* on *Numenius*.

Genotype: *Dollabella testudinarius* Denny.

DOLLABELLA TESTUDINARIUS D. (8, p. 96). (Text-fig. 23.)

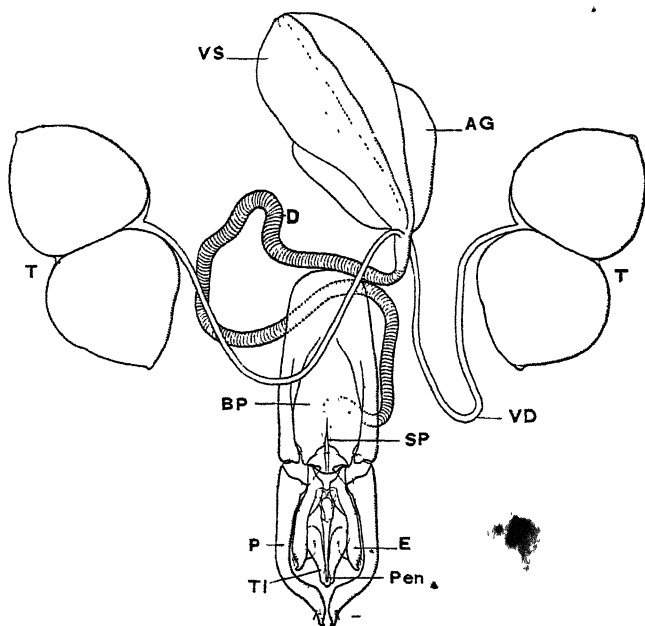
Several specimens from *Numenius phaeopus* (Linn.).

Male Reproductive System.—In proportion to the *resicula* the testes are very large, roughly pyriform, nearly as broad as long. The *resicula seminalis* is elongate, pear-shaped, with a median longitudinal groove. The rather elongate accessory glands, one on each side, lie alongside of it in the posterior portion, and enter the top of the ductus. The *ductus ejaculatorius* is long and narrow, with several loops.

Male Copulatory Apparatus.—*Basal plate*: In front for a little more than a third of its length it is evenly chitinised and of a uniform brown colour. Behind, strong lateral margins with a clear membranous area between. At each lower lateral angle the articular surface is oblique, passing downwards from within outwards. A small angular process projects a little beneath the base of each paramere. *Parameres*: Slender, elegantly moulded rods, which a little after halfway turn inwards in a pronounced bend, and then run straight forwards to the distal end. The base of each paramere is characteristic in shape, being roughly quadrilateral, with two sharply defined posterior angles. Halfway down, in the middle of its dorsal surface a minute hair on each paramere; subapically on the outside another minute hair. *Mesosome*: This includes the endomeres, an upper and a lower, of complex form, the upper one possessing subapically on each of its

two limbs two directive hairs in large alveoli. Between lies the penis, a rod with a large wing-like telomere on each side composed of rather transparent delicate chitin.

Text-figure 23.



Dollabella testudinarius. Male reproductive system and copulatory apparatus.
× 75.

T. testis. *VS.* vesicula seminalis. *AG.* accessory gland. *D.* ductus. *BP.* basal plate. *SP.* median splint. *P.* paramere. *E.* endomere. *TI.* telomere. *Pen.* penis. *VD.* vas deferens.

THE REST OF THE PHILOPTERI.

The species of *Philopterus* in the collection remaining to be considered are five in number:—

PHILOPTERUS COMMUNIS N. (5, p. 85).

A single ♀ in company with *Nirmus cyclothorax* N. from *Passer domesticus* (Linn.).

PHILOPTERUS SEMI-SIGNATUS N. (5, p. 80).

Two ♀ ♀. Host's name not given.

The difficult question of the Corvine *Philopteri* is discussed by Waterston (21).

PHILOPTERUS LARI Denny (8, p. 89).

Five ♀ ♀ from *Numenius arquata* (Linn.). A straggler from Gulls.

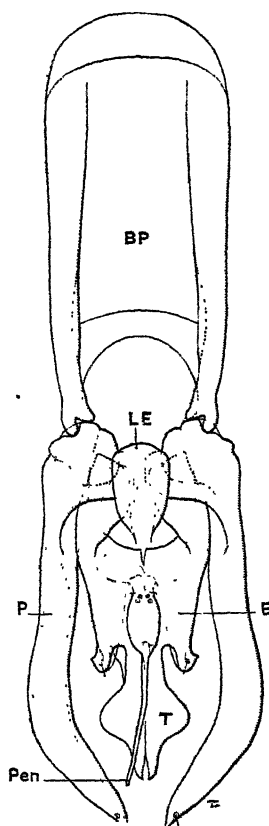
The male copulatory apparatus is figured by Snodgrass (1, pl. xiv. fig. 8).

PHILOPTERUS LEONTODON N. (5, p. 90).

A single male from *Psaroglossa spiloptera* (Vigors).

A common parasite on Starlings, occurring in several different forms; probably a new genus should be established.

Text-figure 24.



Philopterus acanthus. Male copulatory apparatus. $\times 150$.

BP, basal plate. LE, lower endomere. P, paramere. E, endomere.

Pen, penis. T, telomere.

PHILOPTERUS ACANTHUS C. (5, p. 101). (Text-fig. 24.)

Two ♀ ♀ in company with *Nirmus ochropygus* on *Hematopus ostralegus* (Linn.).

I am able to describe the male copulatory apparatus from a preparation kindly lent me by Mr. Waterston. This belongs to much the same type as that in *P. humeralis*.

Male Copulatory Apparatus.—*Basal plate*: The characteristic feature is its small width in proportion to the dimensions of the parameres and mesosome, which are attached to it. Basal transverse band very convex. *Parameres*: Large powerful rods, with large circular condyles working over the tiny articular surface offered by the posterior lateral angles of the basal plate. Distally they bend in somewhat towards one another. Subapically a minute hair. *Mesosome*: There are two endomeres, a lower and an upper, the former being a small deeply bifid plate, each limb of the fork running out behind into an attenuated tip. The upper endomere has two wings, narrower at the distal end than in *P. humeralis*, and here solely consisting of the lateral tooth or notch pointing outwards. The *penis* is a delicate rod with a large bulbous base (hypomere); above lie the "winged" telomeres, which together look like a javelin's head.

A comparison between text-figures 22, 23 & 24 clearly indicates the homologies between the parts in the three species.

Family LIPEURIDÆ.

THE LIPEURI OF STRUTHIOUS BIRDS.

Degeeriella asymmetrica N. is found on the Emu (*Dromæus novæ-hollandiæ* (Lath.)), *Lipeurus asymmetricus* P. on two species of Rhea (*Pterocnemia pennata* (D'Orb.) and *Rhea macrorhyncha* Scl.), *Lipeurus quadrimaculatus* P. on *Struthio camelus* Linn. and *Rhea americana*, *Lipeurus latus* P. on *R. americana*. There can be but little doubt that these four species are related to one another and should be grouped together. Subsequent research and the rediscovery of Piaget's *L. latus* will probably result in the establishment of three new genera placed together in a new subfamily.

Harrison (22) has already suggested that *D. asymmetrica*, *L. asymmetricus*, and *L. quadrimaculatus* should be regarded as congeneric. From the new genus established below to include *L. asymmetricus* and *L. quadrimaculatus*, I have omitted *D. asymmetrica*, as in my opinion it should stand in a genus by itself. It is a curious and significant fact that in three of these species parasitising Struthious birds the margin of the anterior part of the head is from some cause by no means evident asymmetrically developed. The asymmetry in the anterior incrustation of the head is least developed in *L. quadrimaculatus*, while in the larva of this species, as well as in the larva of *L. asymmetricus*, the asymmetry is absent even in Stage II. That *D. asymmetrica*, in which the adult asymmetry is most developed, the whole of the

preantennal region being bent over on itself to form a longitudinal channel, is a derivative of the other two species seems clear from the observation made by Harrison that the larvæ of *D. asymmetrica* possess asymmetrical heads of "a precisely similar structure" to that found in the adults of the other two.

A great deal more collecting and investigation are necessary before any satisfactory conclusions can be drawn upon the relationship of the Mallophaga parasites to their Struthious hosts.

STRUTHIOLEPUS, gen. nov.

Lipeuroid; antennæ sexually dimorphic. Incrassations of anterior margin of head placed asymmetrically. Left mandible with an enormous basal process almost as large as the mandible itself. In the thorax clavicles present as thin splints running inwards and backwards from the antero-lateral angles to join a band which goes vertically downwards to be inserted into the transverse acetabular bar. Abdomen with thinly chitinated transverse tergites. Two transverse rows of fairly long silky hairs on each tergite. Hairs at the sides numerous and fairly long. Male copulatory apparatus characteristic.

Genotype: *Struthiolepus asymmetricus* Piaget (23, p. 54).

The genus to include *S. quadrimaculatus* P. (3, p. 298).

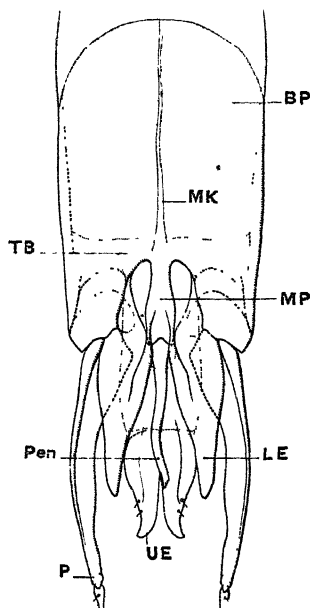
STRUTHIOLEPUS ASYMMETRICUS P. (Text-fig. 25.)

I collected several specimens of this species personally on a live Rhea in the Gardens.

Male Copulatory Apparatus.—*Basal plate*: Dorsally trough-shaped, with a longitudinal median keel. At the posterior end the sides of the trough become steep, and a bridge runs across from side to side in the form of a fairly narrow transverse band, from the middle third of which a parallel-sided plate runs forward between the parameres, ending in a straight truncate margin, to which the upper endomeres are attached. Beneath this transverse band is another running across the floor of the trough from side to side. Like the dorsal one this sends forward a median piece between the parameres, and near the end of it the penis arises. The posterior lateral angles of the basal plate are much produced, deep dorso-ventrally, and square. *Parameres*: long tapering rods, the apex curiously formed (see text-fig. 25, P). *Mesosome*: Each upper endomere is roughly triangular, being broad at the base and narrowing towards the tip, where it is slightly decurved. The piece may best be likened to the rhamphotheca of some bird of prey when macerated off the skull; it is actually double, being bent upon itself, the two leaves gaping wide enough to admit of the introduction of the dissecting-needle. In this way each upper endomere "gapes" outwards. The lower endomeres take origin further back, one on each side of the base of the

penis. They are slender and wedge-shaped, rather long. The *penis* is a long, narrow, elongate rod, with a somewhat swollen base, which lies almost buried between the dorsal and the ventral median processes of the basal plate.

Text-figure 25.



Struthiolipeurus asymmetricus. Male copulatory apparatus. $\times 140$.

BP. basal plate. MK. median keel. TB. transverse band. MP. median piece.

Pen. penis. LE. lower endomere. P. paramere. UE. upper endomere.

THE REST OF THE LIPEURI.

LIPEURUS SUBSIGNATUS Giebel (5, p. 232).

Several specimens, including a male, from *Phenicopterus roseus* Pall.

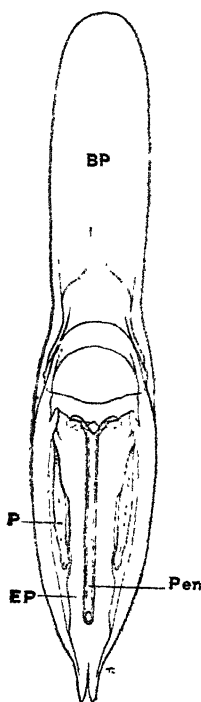
LIPEURUS JEJUNUS Nitzsch (5, p. 240). (Text-fig. 26.)

Males, females, and larvæ from *Branta leucopsis* (Bechst.).

Male Reproductive System.—This was carefully figured and described by Kramer as long ago as 1869 in the 'Zeitschrift für wissenschaftliche Zoologie' (12). Testes and vas deferens as usual. The *vesicula seminalis* is an elongate double-chambered sac, the median partition indicated externally by a longitudinal groove.

Male Copulatory Apparatus.—*Basal plate*: Rather long, narrow, of uniform thinness, the lateral margins indistinct, and the colour dull greyish. *Mesosome*: Attached to the posterior margin of the basal plate is a large, broad, trowel-shaped plate—the mesosome. When the apparatus is withdrawn, as shown in the figure, the parameres, slender rods shorter than the mesosome, lie dorsally

Text-figure 26.



Lipeurus jejunus. Male copulatory apparatus. $\times 130$.

BP. basal plate. P. paramere. EP. endomerale plate. Pen. penis.

and inside the lateral margins of the mesosomal plate. When the apparatus is in action, however, the base of the mesosome swells up and broadens out, carrying the parameres with it, so that the latter come to lie laterally in their normal position. The penis is a perfectly straight elongate tube, with an aperture at its tip and with a forked base.

LIPEURUS HETEROGRAMMICUS N. (5, p. 220).

Plenty of material of this minute species was sent, collected on *Caccabis chukar* Gray.

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L. PEURUS ANTILOGUS N. (5, p. 223).

Males, females, and larvæ in numbers from *Eupodotis edwardsi* (Gray & Hardw.).

The specimens were identified from Piaget's description and figure (3, p. 374, pl. xxx. fig. 3), with which, however, they did not entirely agree. After examination of authentic *L. antilogus* the Society's specimens may emerge as a new form.

LIPEURUS VARIABILIS N. (5, p. 219).

Several specimens of both sexes from *Phasianus scintillans* Gould.

This is a difficult species, of which several varieties have been described. All the material badly needs overhauling and dissection in conjunction with allied species.

LIPEURUS BURNETTI Packard (24). (Text-fig. 27.)

Two ♂♂ and 4 ♀♀ from *Polyplectron chinensis* (Müll.).

The description which follows is incomplete, as the material was insufficient to settle the question of the preputial sac, which is therefore omitted.

Male Copulatory Apparatus.—*Basal plate*: Unusually broad, with very narrow, lateral, marginal bands. Anterior margin very convex. *Parameres*: Quite short and inwardly curved. *Endomerical plate*: This is much longer than the parameres and at the base almost as broad as the basal plate. Behind, it sends forward a narrower parallel-sided portion shaped something like a duck's bill (see text-fig. 27). Note the peculiar sculpturing of the inner surface of the paramere.

LIPEURUS SECRETARIUS G. (5, p. 213).

Many specimens from *Serpentarius serpentarius* (Miller).

This species belongs to a well-defined group of large handsome Lipenrids infesting birds of prey and characterised by the four or six curious, more or less circular incassations on the front margin of the head. They undoubtedly form the material for a new generic group.

LIPEURUS FORFICULATUS N. (5, p. 238).

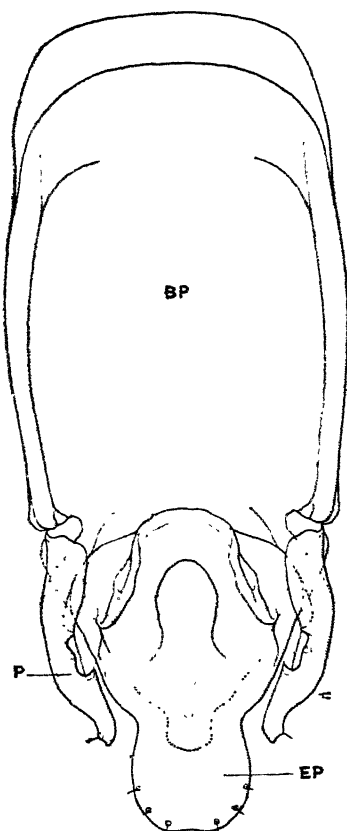
A goodly number of specimens of both sexes and larvæ from the Red-backed Pelican (*Pelecanus rufescens* Gmel.).

This species, readily distinguished from *L. bifasciatus* P. by the shape of the antennæ in the male, is found on *P. onocrotalus* Gmel. The present specimens were paler in colour than is usual in this species.

Larvæ.—Two stages, probably I. and II., have been figured by Kellogg without any comment (25). The chaetotaxy of the abdomen in Stage I. (?) shows the common and perhaps primitive arrangement of two hairs on each dorsum in the middle field. In

Stage II. (?), the only stage included in this collection, there are two hairs on the dorsum of each segment, two on each pleura (very short on segments I. and II.), and on segments VI. and VII. a long hair behind each spiracle. On the sterna there are four hairs in each segment excepting on the last two segments, where there are only two. As compared with Stage I. (?) there

Text-figure 27.



Lipenrus burnetti. Male copulatory apparatus. $\times 180$.

BP, basal plate. P, paramere. EP, endomerale plate.

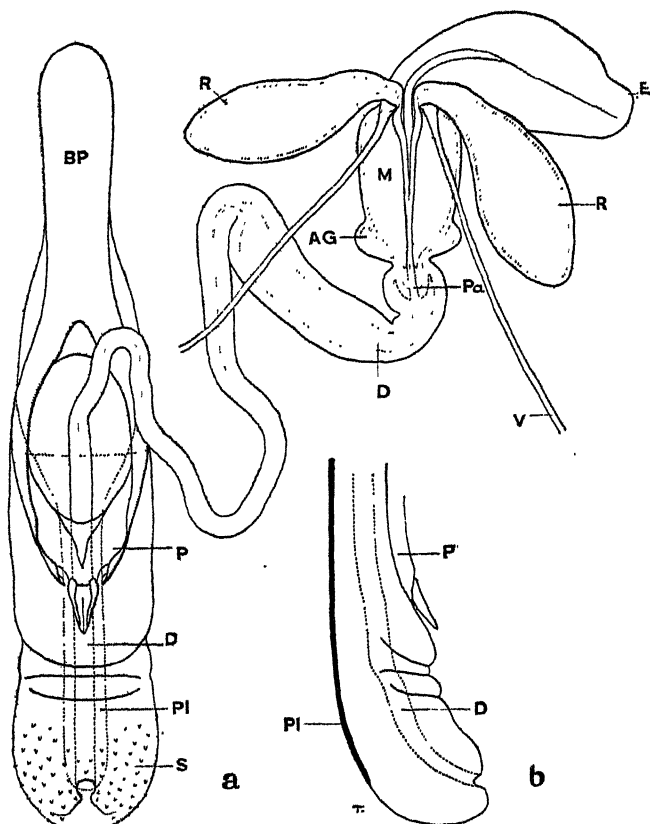
Note the sculpturing of the paramere.

is a slight difference in the grouping of the hairs on each side of the hind margin of the meta-notum.

Male Reproductive System (text-fig. 28).—The *testes* and *vasa deferentia* require no special mention. The rest of the parts are

complex in structure, consisting of an oval end-sac—the true *vesicula seminalis*—which leads by a narrow neck into a second well-defined portion, for convenience of description called the middle-sac. Further, elongate reservoirs, elegantly flask-shaped,

Text-figure 28.



Lipceurus forficulatus. Male reproductive system and copulatory apparatus.
X 105.

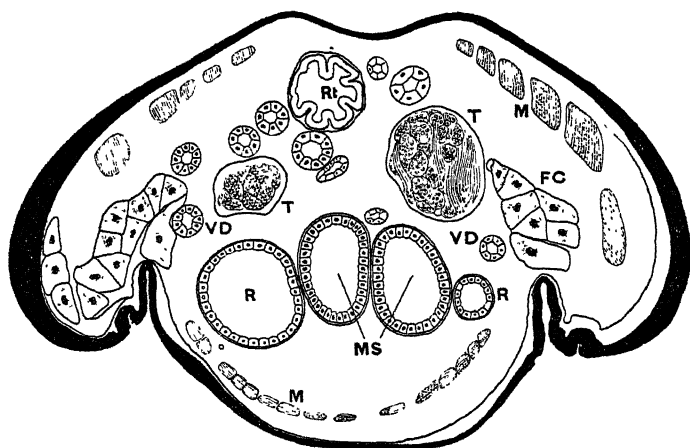
a. seen from above; *b.* seen from the side. Testes not shown.

BP. basal plate. *P.* fused parameres. *D.* ductus. *Pl.* strip of narrow chitin along ventral surface. *S.* extrusible sac. *R.* reservoir. *E.* end-sac of vesicula seminalis. *M.* middle-sac. *AG.* accessory gland. *Pa.* cone-shaped papilla. *V.* vas deferens.

When *in situ* the vesicula and associated parts lie much further forward in the body-cavity in front of the basal plate, and the sac when extended in copulation curls over the back of the abdomen.

lie, one on each side of the middle-sac, and enter by a narrow neck into the narrow section between the end-sac and middle-sac. The text-figure shows the connections at this point with the *vas deferens*. The *ductus ejaculatorius* for a considerable portion of its course on leaving the middle-sac is large and glandular and almost as broad as the middle-sac itself. The narrow canal between the latter and the ductus projects into the lumen of the ductus as a minute cone-shaped protuberance. The broad upper part of the ductus, after two bends, giving the tube an S-shaped form, narrows into a small canal of several coils, which enters lower down into the upper part of the retracted preputial sac.

Text-figure 29.



Lipeurus forficulatus, ♂. Transverse section through the abdomen at the level of the middle-sac of the vesicula. (Diagrammatic.)

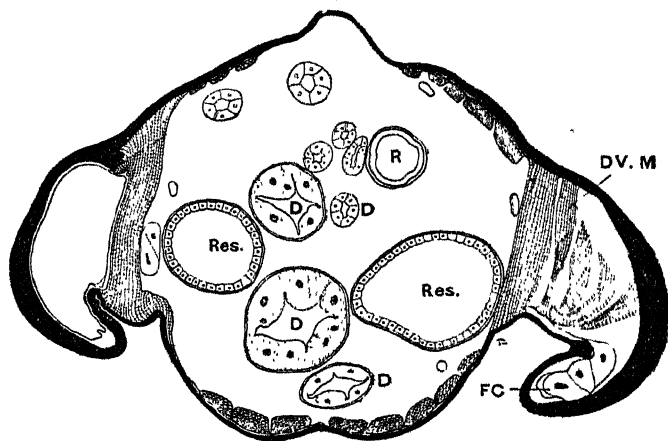
Rt, rectum. T, testis. M, muscles. FC, fat cells. VD, vas deferens.
R, reservoir. MS, middle-sac.

Sections of these parts reveal some important points (see text-figs. 29 & 30). Externally the end-sac is marked by a median longitudinal groove. In cross-section the mid-sac, as in the *vesicula seminalis* of other insects, is seen to be double, consisting of two distinct tubes closely applied one to the other. Similarly, the middle-sac is also double. Whereas the end-sac contains sperm, the two "reservoirs," the middle-sac, and the two minute vesicles, one on each side at the lower end of the latter, contain a conglutable white secretion, which possibly plays the part of spermatophragmen, serving for the maintenance of the spermatozoa during copulation.

The walls of the end-sac are fairly thin. Those of the middle-

sac are thicker, the cells being of varying lengths and their ends projecting irregularly into the lumen. The walls of the flask-shaped reservoir are very thin, consisting of a clear hyaline external membrane and an inner epithelium of short cells. The walls of the upper portion of the *ductus ejaculatorius* are very thick, consisting of extremely high cells, the shape of which is not clear in the preparations on account of unsatisfactory fixation. For the same reason the histology of other parts remains obscure.

Text-figure 30.



Lipewrus forficulatus, ♂. Transverse section through the abdomen, behind the middle-sac of the vesicula. (Diagrammatic.)

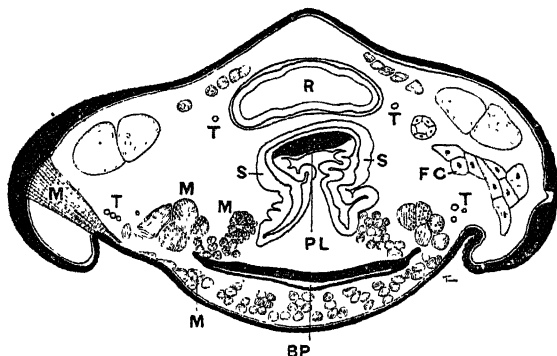
R. rectum. *D.* ductus. *Res.* reservoir (lower end). *DV.M.* dorso-ventral muscles. *FC*, fat-cells.

Male Copulatory Apparatus (text-fig. 28).--The copulatory apparatus belongs to the simple type, consisting of basal plate and parameres and an extrusible membranous sac (see Part I., p. 257). Fortunately in the collection were two males with the sac extruded, and, as usual, when in this condition turned upwards and backwards over the terminal segments of the abdomen. A detailed account is therefore included of the sac when extruded and when retracted, with some remarks upon the mechanism of extrusion and retraction.

The *basal plate* is rather long and narrow, of a dull grey colour, the lateral margins a little concave. The *parameres* at their distal ends are fused with one another. The text-figure shows that the fused parameres are dorsal to the sac which shoots outwards and upwards from under the chitinous arch formed by the parameres. The sac proximally possesses two characteristic transverse rolls caused by two deep furrows. Distally it is studded with a number of minute denticles and its opening is

subterminal on the dorsal surface. From between the parameres and continuous at that point with the basal plate is a small endomerteral plate continued backwards as a long, narrow, thick, parallel-sided, chitinous strip which supports the sac on its lower side along the middle line. The ductus can be seen through the wall of the sac running backwards into the abdomen, where it lies on the dorsal side of the basal plate.

Text-figure 31.



Lipceurus forficulatus, ♂. Transverse section through the abdomen showing the copulatory sac lying retracted within the body-cavity above the basal plate. (Diagrammatic.)

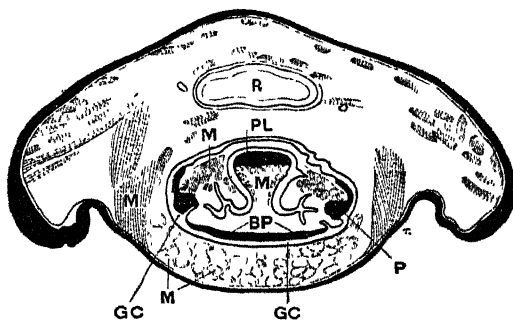
R. rectum. T. trachea. S. sac. PL. narrow chitinous strip on ventral surface of sac. M. muscles. FC. fat-cells. BP. basal plate, showing the rift.

The Apparatus when retracted.—During retraction the sac is continuously invaginated until the distal end with its denticles comes to lie farthest forward within the abdominal cavity a little anterior to the fore end of the basal plate. The thick endomerteral strip on its lower wall, of course, curls upwards and travels in with the rest, so as to form in the retracted state an enigmatic loop difficult to interpret until an extruded sac is examined. In cross-section, therefore, the endomerteral strip forms the lower wall of the *inner* tube (see text-fig. 32). A similar endomerteral loop with a similar history was described in Part I, p. 271, for *Trichodectes latus*. The diagram should make the relation of the parts quite clear.

It should be clearly understood that the parameres are at no place rods or appendages discrete from the sac. At their distal end (text-fig. 33) a membrane crosses between them dorsally and another membrane crosses ventrally. If the parameres became shorter these two membranes would become continuous with one another and with the dorsal wall of the outer tube, and if, finally, they disappeared we should have a simple exsertile tube. Sections anywhere across the length of the parameres all show

them to be local chitinisations one on each side of a membranous tube—the outer tube. In text-fig. 32 a section is shown of this outer tube contained within the genital chamber, and the basal plate and parameres are seen merely as local thickening in the continuous wall of the sac.

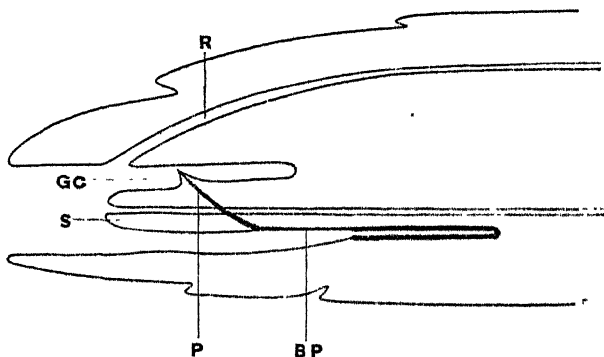
Text-figure 32.



Lipeurus forficulatus, ♂. Transverse section through the genital chamber, with the copulatory apparatus retracted. (Diagrammatic.)

R. rectum. *M.* muscles. *PL* chitinous strip on ventral surface of the sac. *BP* basal plate between the base of the parameres (*P.*). *GC* genital chamber.

Text-figure 33.



Lipeurus forficulatus, ♂. Longitudinal section through the end of the abdomen. (Diagram.)

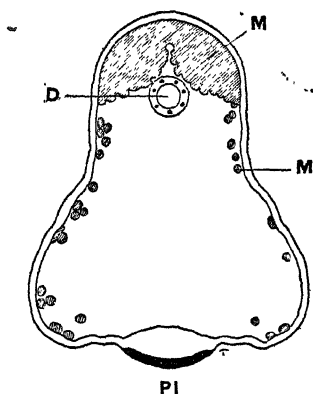
R. rectum. *GC* genital cavity. *S.* sac. *P.* paramere. *BP* basal plate.

Now, if reference be again made to the diagram (text-fig. 33) it is evident that the dorsal sector of the genital chamber ends much sooner than the ventral. Reading the sections forwards

establishes beyond doubt the interesting character of the basal plate. The sole remaining ventral part of the genital chamber becomes smaller and smaller until it is no more than a narrow cleft below the basal plate. Next, its lower wall becomes chitinous and is approximated to the basal plate, which is for the rest of its course a circle of chitin squashed perfectly flat into a plate with only a narrow rift between (text-fig. 31).

The interest in this observation centres in the fact that it explains the nature of the basal plate. At the base (near the parameres) this begins as an ordinary squamiform apodeme on the lower wall of the sac within the genital chamber. It runs back (*i. e.* in the direction of the head) as an ordinary tubular apodeme formed as an invagination of the ectoderm in the lower part of the genital chamber. This "tube" is compressed into a flat plate and its lumen reduced to a thin rift—continuous with the genital chamber.

Text-figure 34.



Lipeurus forficulatus, ♂. Cross-section through the extruded sac just behind the opening.

D. ductus. M. muscle mass. Pl. narrow chitinous strip on ventral surface.

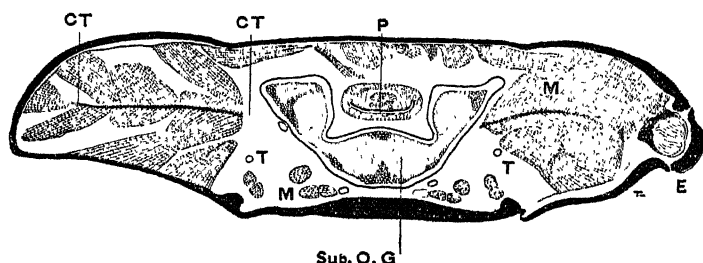
Extrusion and Retraction.—On the ventral surface of the basal plate there is a series of longitudinal muscles which arise in front from the anterior portion of the basal plate and are inserted behind into the terminal sternite of the abdomen, serving to thrust the plate forward and expose the parameres through the terminal abdominal opening. Text-fig. 28 *a* shows that the parameres along their dorsal margin curve in somewhat. Underneath this overhanging ledge small muscle-fibres run back along the length of the parameres and are attached to the base of the basal plate, doubtless serving to draw the tip of the fused parameres upwards in a dorsal direction, which is its usual position when in

copulation. On each side of the basal plate is a large-bellied muscle arising from an abdominal sternite some way forward and inserted by a delicate tendon into the lower end of the basal plate. These are retractor muscles, withdrawing the apparatus within the body after copulation. The continuous invagination of the sac is brought about by the contraction of a great many small muscles arising from the dorsal surface of the basal plate and inserted successively along the walls of the sac. They are particularly numerous above the ductus at the distal end of the sac, being inserted just behind the opening (text-fig. 34).

Extrusion of the sac is probably caused by blood-pressure upon contraction of the powerful dorso-ventral abdominal muscles segmentally arranged.

The above is not offered as a complete account of the mechanism of this complicated apparatus. The manifest lacunæ in the description must be filled in only after a great deal more study of the parts.

Text-figure 35.



Lipewrus forficulatus, ♂. Transverse section through the head behind the antenna. (Diagrammatic.)

CT, chitinous tendon for attachment of mandibular muscles (M). P, pharynx.
T, trachea. Sub. O. G., subesophageal ganglion. E, eye.

Mouth-parts.—*Labium*: The labial sclerite is present merely as a narrow transverse band near the anterior margin. *Isopugometric Apparatus*: Lyriform organ without posterior cornua. Anterior cornua are broad and flat, convex on the outer margin, and in length equal to that of the "nucleus" itself; from each side a chitinous bar runs up the wall of the pharynx, which is further supported dorsally by a short median longitudinal splint. Behind the lyriform organ the chitinous intima of the pharynx bears a number of minute teeth. As in *Lipewrus ferox* (9, text-fig. 24) there is a compound hypopharynx consisting of a narrow, short, median piece, and on each side a longer rectangular strip. The pharynx (see text-fig. 35) is supplied with numerous small muscles—circular, longitudinal, and transverse. The latter are developed further forward, and consequently do not appear in the

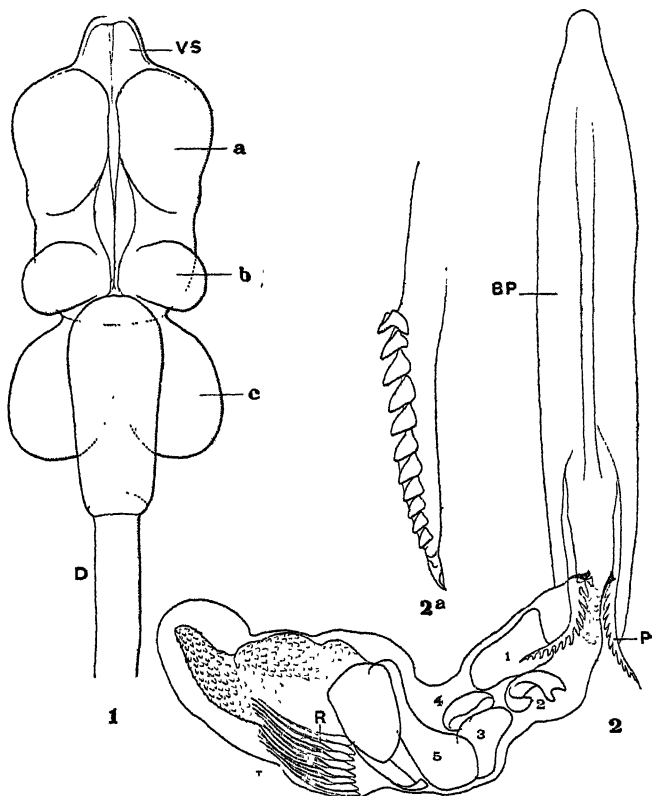
text-figure. There are two pairs, one running from the ventral and the other from the dorsal side of the skull.

Genus *PECTINOPYGUS* Mjöberg.

PECTINOPYGUS PULLATUS Nitzsch (5, p. 236).

From time to time a considerable amount of material of this species from *Sula bassana* (Linn.) and from the Cape Gannet (*Sula capensis* (Licht.)) was sent in.

Text-figure 36.



Pectinopygus pullatus, ♂. 1. reproductive system. 2. copulatory apparatus. $\times 90$. 2a. paramere enlarged. $\times 270$. Testes and vasa deferentia not shown.

VS. vesicula seminalis. a. b. c. lobes. D. ductus. BP. basal plate.

P. paramere. R. retinaculum. 1-5. sclerites on the sac.

Male Reproductive System (text-fig. 36).—The *vesicula seminalis* is complex. It consists of a large, swollen, two-chambered sac

of somewhat irregular contour and outline. At the anterior end are two small, closely united offshoots from the central chambers, and at the posterior end, where the *vesicula* joins the *ductus*, are two pairs of accessory lobes each attached to the vesicula by scarcely any appreciable neck or constriction. The first pair of lobes are quite small and lie postero-ventrally. The second pair run backwards side by side above the issuing ductus, and are nearly half as long as the vesicula and together almost as broad. The *ductus ejaculatorius* is broad at its upper end and rather short. About midway towards the copulatory apparatus there is a small bend where a pair of small glands are attached.

Male Copulatory Apparatus.—Throughout the Mallophaga, as indeed in Insects generally, the structure of the male apparatus for copulation displays a remarkable variety. In the Mallophaga the strangest condition is found in *Pectinopygus pullatus* (see text-fig. 36). Mjöberg (6, p. 246, fig. 139), who established the genus, in purporting to describe and figure the apparatus describes only the basal plate, parameres, and ductus. The whole long extrusible sac, with its complex chitinisations, is omitted—swept away in dissection possibly in mistake for the rectum or rectal faecal matter. *A propos* of the sac, Mjöberg states that, although present, it is “jedoch nicht gut entwickelt.” And of the *ductus ejaculatorius*: “Er zeigt in der Innerwand ein in einer Spirale verlaufendes Chitinband.” But the *ductus* contains no such spiral band, and as it is difficult to suppose Mjöberg mistook the extrusible “preputial sac” for the ductus, there may be here a question of a distinct but unrecognised species.

Basal plate.—This is long and narrow, with a longitudinal median keel upon its lower surface. The two peculiar processes (P), which probably represent parameres, do not articulate with the basal plate, but are attached to its dorsal surface along the length of the whole “stalk” or unpectinated portion. The distal end is band-like and curves outwards. On the inner surface of each are about thirteen denticles like sessile buds on a stalk, graduated in size from the base to the tip. Below and quite continuous with the basal plate lies an endomerale plate, formed of a rather clear chitin, the upper surface presenting a tessellated appearance. In regard to the “preputial sac,” the text-figure lays no claim to a representation of this in the natural position. Unfortunately no male specimen was obtained with the sac extruded. Consequently the remarkable sclerites 1, 2, 3, 4 and 5 are shown lying in no very intelligible position. However, the shape of the pieces is seen together with the structure of the large “retinacular comb” at the distal end, recalling a similar structure figured for *Anataeus*. The “comb” in *Pectinopygus* consists of a row of about nine elongate bands. Each band at the base has square angles, is fairly broad and parallel-sided for a short distance up before it divides into two, forming a fork with two elongate prongs. All the nine forks are really one

continuous piece, the divisions between being filled by a sort of amalgam of thin transparent chitin,

The whole of these pieces, as well as the basal plate and parameres, which in their ensemble Berlese conveniently collects under the name *Perifallo* (26), are, it must be remembered, simply chitinous plaques developed upon the outside tube of the apparatus. In *Pectinopygus* these are remarkable from their miscellaneous character, whereas in other Mallophaga the mesosomal parts are usually capable of ready classification into the endomeres and telomeres and penis.

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32. On Two new Species of Cestodes belonging respectively to the Genera *Linstowia* and *Cotugnia*. By FRANK E. BEDDARD, M.A., D.Sc. (Oxon.), F.R.S., F.Z.S.

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I. *Description of Linstowia lemuris*, sp. n.

Sexual Tapeworms from Lemurs being but little known, I was specially interested to obtain from the small gut of an example of the Slow Lemur (*Nycticebus tardigradus*) two complete specimens of a Cestode, besides a large fragment which was found to belong to the same species. I refer this new worm to the genus *Linstowia*—at any rate, for the present,—giving reasons later after a due consideration of its anatomy.

The worms are about three inches in length, the varying contraction rendering it impossible to give an accurate measurement in either case. The greatest diameter is 4 mm. The *scolex* is almost spherical in form and of some size (1 mm.); it is succeeded by a short neck, where no strobilisation is visible. The scolex is quite unarmed as to the suckers, and there is no rostellum at all. The *suckers* are closely grouped on the anterior face of the scolex, and not in the least lateral in position. The only other external character of systematic importance, the position of the generative orifices, was not apparent until the worm was investigated by sections. They alternate from side to side, being mainly massed upon one side, as many as ten being sometimes successively upon the same side of the body. There is thus nothing distinctive as to the systematic position of the worm to be gained by an examination of the external characters only, as is nearly always the case with Cestodes—a very few can be identified without recourse to anatomical study.

In transverse sections the *cortex* is seen to be of about the same diameter as the medulla. The longitudinal muscles have a characteristic arrangement which is in one way peculiar. In addition to transverse fibres which bound the longitudinal layer internally, as in most other Cestodes, the present species shows similar fibres between the innermost of the longitudinal fibres themselves, an arrangement which is, of course, well known as characteristic of the Acoleidæ and of the genus *Cotugnia* among the Davaineidæ (see p. 700). This transverse layer between the inner and outer layers of the longitudinal sheet consists of single delicate fibres, which are, however, quite

obvious, and in being singly distributed remind us of *Cotugnia*, and not of the Acoleidae where the layers are stronger. I have re-examined other species of *Linstoria* to ascertain whether this peculiarity is or is not confined to *Linstoria lemuris*. I find the same delicate transverse fibres between the longitudinal bundles in *L. ameiva* and also in *Oochoristica marmosa*, a species which, as I have already pointed out in describing it*, is hard to refer decisively to either *Linstoria* or *Oochoristica*, a matter to which I recur later. However, in a *Linstoria* from *Echidna*, the specific identity of which I am not certain, there was no supplementary transverse layer of muscles. Nor did I find anything of the kind in *Oochoristica* from *Tamandua tetradactyla*, the structure of the body-wall of which would, however, render this arrangement impossible, as may be seen from my figure of the same†.

The longitudinal muscles are disposed in an inner and an outer series. As to the former, there is a layer of thick fibres, sometimes two or three or even five or six massed together. Outside this there lies another layer of the same kind, but imperfectly defined. The outer layer of longitudinal muscles consists merely of scattered fibres of less size than those already dealt with. There is here no sharply defined formation of layers. The additional transverse fibres already mentioned are associated with the inner layer of stouter muscle-fibres.

The *excretory system* is, like that of some other species referred to the two genera *Oochoristica* and *Linstoria*, characterised by a network quite easy to detect but not easy to map accurately. I have found at least three branches arising from the ventral vessel and extending towards the middle of the proglottid. These do not, however, cross as unbroken tubes, but are dissolved into a network.

The *testes* lie dorsal to the ovary and vitelline gland and lateral of the same. They extend from side to side of the proglottid, but do not invade the cortex. I counted about nineteen in a single row. There are two of these rows in a transverse section, and horizontal ones show also two rows, in parts increased to three. The *cirrus-sac* in this species is small and extends a little way beyond the nerve cord—in fact, as far as the lateral vessel. This might appear to mean that it is after all not so small; but the width of the proglottids is such that the sac occupies but a short space of the transverse diameter, and it is thus relatively small. The sac lies at the bottom of a deep genital cloaca; this involution from the exterior narrows abruptly internally to a narrow passage which opens into a wider sac, which receives the male and female ducts and is a common male and female atrium. Such an arrangement is common among

* P. Z. S. 1914, p. 269.

† *Ibid.* p. 270, text-fig. 4, D. It will be noticed that there is no marked gap between the longitudinal layers allowing of the intercalation of a transverse layer as in *Linstoria lemuris*.

Cestodes, and occurs for instance, in the present genus, in *Linistowia ameivæ*. The cirrus-sac itself is oval in longitudinal section, and at times almost circular. It has a thickish external muscular layer, and is not differentiated into regions as is sometimes the case with the cirrus-sac, where the internal region is thinner-walled and occasionally swollen. Owing to the small size of the cirrus-sac, the contained cirrus and vas deferens are not much coiled, and the lack of room has brought about quite a short cirrus, which is of about the same length as the section of the vas deferens which lies within the cirrus-sac. As in other Cestodes, the contents of the cirrus-sac (which together with the external muscular layer forms the wall of the cirrus) and a section of the vas deferens can be extruded with the cirrus. To this complex it is perhaps convenient to give the name of penis, as I have elsewhere suggested.

The *vas deferens* on emerging from the cirrus-sac forms a loosely arranged coil which lies to the ventral side of the cirrus-sac, the interstices between the coils being filled with glassy cells—the so-called prostate. Upon this ensues a straight course of vas deferens, which lies upon the dorsal side of the cirrus-sac in relation to the dorsal position of the testes.

The *ovary* is seen in transverse sections to lie dorsally of the vitelline gland. It has a structure common in Cestodes, ending laterally in numerous drawn-out processes which are often club-shaped at the free extremities. The ovary extends further laterally than the vitelline gland, which it thus completely overlaps. It is, of course, also anterior in position.

The *vagina* of this Cestode shows the same subdivisions in its course that are shown in other Cestode worms, though the relative development of the different sections differs in various genera and species. In the present species the general course of the tube is fairly straight until it divides into the oviduct and the second branch. In mature segments, in which the uterus is still present, though many eggs are scattered through the parenchyma, it can be seen that the vagina consists of four separable regions. The proximal section, opening into the common genital duct before the latter debouches into the cloaca genitalis, is very short, with thick walls and a narrow lumen. The next section occupies the greater part of the vagina, and consists of a tube which gradually widens and ends in the neighbourhood of the ovary in a dilated extremity. This section is covered externally with a layer of deep-staining glandular cells which mark it out from the preceding section. This part of the vaginal tube is specially developed in the present Cestode, and in fully mature proglottids, where the parenchyma is entirely occupied by the scattered embryos encircled with their membranes, is the most conspicuous region of the vagina; it presents here the appearance of a large sac. It is, in fact, here almost divisible into two regions: a narrower part which is proximal, and which—wide itself—dilates suddenly into a large oval sac

which appears to be the termination of the vagina, and is practically so since the remaining part has dwindled away. It presents, in fact, the appearance of a large spermatheca in an Oligochaetous annelid, and is very unlike the usual form of this part of the vagina in tapeworms, though there are forms which show some likeness to it. It never lodges ova. I shall recur to the structure of this sac in comparing it with the corresponding region of the vagina in other Cestodes. After this middle region of the vagina the tube suddenly narrows to a fine canal*, which emerges quite abruptly from its distal and dilated end. This latter tube is of some length and ends in quite an unusual fashion. Instead of opening into a dilated sac, the receptaculum seminis, as in so many tapeworms, the tube opens into a wider horseshoe-shaped tube, of which the two ends become respectively the duct going to the ovary and that ending in the shell-gland. This region is crammed with spermatozoa, and seems to be undoubtedly a cleft receptaculum seminis—that is to say, the ultimate separation of this region of the female efferent apparatus into oviduct and duct communicating with the vitelline gland through the shell-gland, occurs earlier than is usual and concerns the receptaculum itself. This interpretation is, I think, justified by a comparison of the present species with *Oochoristica marmose*, a description of which I have lately communicated to this Society†. It will be noticed that the vagina of *Oochoristica marmose* shows the same regions as that of the species with which I am concerned here, but that the relative development of the regions differs. Thus the middle region covered externally with gland-cells is short but dilates at the distal end, though to a much less extent than in the present species. The proximal section is very long, and the receptaculum seminis is a more or less cylindrical widish tube not divided longitudinally as in the new worm described in the present paper. I have mentioned that in fully mature proglottids the middle region is much altered. It occupies more than half the breadth of the proglottid, and the end which appears to end blindly sometimes curves rather backwards. This part is very much more swollen than the more tubular section which runs towards the external pore.

The uterus of this worm is like that of other members of the genera *Einstovia* and *Oochoristica* in its broad features; but there are some differences that require description. The uterus is, on the whole, very like that of *O. marmose*‡; it is in the same way ventral in position, underlying the ovary but extending laterally more towards the dorsal surface. Here there is certainly a branched condition of the tubes and spaces to be

* Very rarely (only in one out of a large number examined) are ova found here, and their presence dilates the tube.

† P. Z. S. 1911, p. 271.

‡ P. Z. S. 1911, p. 275, text-fig. 5.

observed, and to some extent a retiform condition obtains, though not so clear as in some other tapeworms. The cavities contain many ova. The walls of the cavities are distinct and nucleated. The suggestion is of flattened cells, and the edges of the cavities which are the actual walls are differentiated from the surrounding parenchyma by a firmness which is marked by a deeper staining. In the greater development of what is obviously a uterus, the present species is plainly nearer to *O. marmosæ* than to *L. ameivæ*. It differs from both in the fact that the ripe embryos, when scattered through the parenchyma after the disappearance of the uterus itself, are not so closely packed. In sections the ripe proglottids seem to contain fewer embryos. Moreover, the individual embryos lie more loosely in the spaces which they occupy. These spaces show no nucleated walls of their own. The embryos extend into the cortex. I could only detect two membranes surrounding the embryo. The embryos appear to be larger than those of *O. marmosæ*.

Systematic Position of Linstowia lemuris.

The species which has just been described must be, as I think, referred to one of the two genera *Linstowia* and *Oochoristica*. The combination of characters shown in the possession of a totally unarmed scolex, single generative organs, a uterus of more or less detached cavities, the final imbedding of the embryos singly in the parenchyma, is unknown elsewhere than in these two genera. I have already, in describing *Linstowia ameivæ* and *Oochoristica marmosæ*, pointed out the impossibility, or at least great difficulty, in rationally distinguishing between these two genera and need not recapitulate here the reasons there given. I may, however, point out what I did not there mention, except by implication, that the founders of the two genera defined them at very nearly the same time (either at the end of 1898 or at the beginning of 1899). Furthermore, neither Zschokke (who is responsible for *Linstowia* *) nor Lühe † (who defined *Oochoristica*) mentions the work of the other. It is doubtful, therefore, whether both genera would be accepted now by these two authors, were they founding them afresh with knowledge of each other's work. I am, however, obliged to admit that Zschokke in a more recent ‡ communication accepts *Oochoristica* without comment, and contrasts its distribution with that of *Linstowia*. I myself believe, on further consideration, that *Oochoristica* will be found to differ by the condition of the uterus—a suggestion which I have already made, but which requires confirmation by an examination of the other species

* The genus was actually defined by Zschokke in *Zeitschr. f. wiss. Zool.* Bd. lxx, p. 441, not in his account of two species in Seimon's 'Forschungsreise,' which is sometimes quoted as the reference for the genus.

† *Zool. Anz.* Bd. xvi, p. 650.

‡ *Zool. Anz.* Bd. xvii, p. 290.

alleged to be of this genus. So important in classification is the condition of the uterus that little doubt, I fancy, will be felt in this matter.

11. *Description of Cotugnia margareta, sp. n.*

The genus *Cotugnia* is usually regarded as of the family Davaineidae, from all the other genera of which it differs by the possession of a double sexual apparatus in each proglottid. The only other character of importance which, so far as is already known, serves to separate *Cotugnia* from other Davaineidae, is the complicated and Acoleid-like disposition of the longitudinal muscle-layer. The examination of examples of a species of this genus from the gut of *Caccabis melanocephala* enables me to add to our knowledge of the genus and to describe a new species thereof.

A large number of examples of this worm occurred in the *Caccabis* in company with an *Hymenolepis*, which is either identical with, or at the least very closely allied to, *Hymenolepis villosa* (known from Bustards). I did not find it associated (except for the doubtful case of one individual) with *Rhabdometra cylindrica*, a parasite from the same species of *Caccabis*, which I have lately described in these 'Proceedings'*..

The extreme length of the worm is about $3\frac{1}{2}$ inches, and it is rather broad, measuring 3.5 mm. The segments are not long and never as long as they are broad. The *scolex* is 1 mm. or a little less in breadth; it is followed by a strobila, which is at first of equal breadth, and in which the segmentation is visible at once. There is, at any rate, no long and well-marked neck. The *suckers* are large and unarmed, and demand no special description.

The *rostellum* of this species shows some interesting characters. In examining the living worm fresh from the body of its host, the *rostellum* is not at all obvious. It is apparently represented by a mere dimple much smaller in extent than the large suckers. The conditions, indeed, reminded me of certain Ichthyotaniidae, where the *rostellum* is represented by little more than an apical pit. In one specimen which I thus examined there was this dimple alone; in another, however, a fringe of minute hooks encircled the pit. These hooks are in a double row and of the Davaineid pattern. In a third specimen, examined after preservation in alcohol and glycerine, the apical pit is quite obvious and encircled by a row of hooks arranged in a double series, which is dumbbell-shaped, being of less diameter in the middle. The whole area surrounded by the hooks is very much less in extent than that of the suckers.

The smallness of the area occupied by the *rostellum* in this species is the first point to which I wish to direct attention.

* P. Z. S. 1914, p. 859.

If my figure (text-fig. 1. p. 702) be compared with Fuhrmann's*, illustrating *Cotugnia polyacantha*, it will be seen that in the latter species the conditions are the exact reverse of that just described. In *Cotugnia polyacantha* the area of the rostellum is much greater than that of any one of the suckers, which are thus small by comparison. The second point to which I draw attention is the apparent occasional absence of hooks. As I have seen these structures, it is fair to suppose that where they were not seen they did not exist. This is a very important matter in the discrimination of Cestodes; it is obviously not yet certain that all hookless genera are really so, except through loss of hooks in individuals.

In transverse and longitudinal sections the rostellum is seen to be a relatively very small structure, which entirely bears out the appearances to be noted when the scolex is seen as a whole, either fresh or, after preservation in alcohol, in glycerine. The retracted rostellum is shown in text-fig. 1, where it is seen to be a very sucker-like structure, although, as already stated, it is very much smaller than the actual suckers.

It is a cup-shaped organ, along the edges of which the hooks can be seen to be implanted. The rostellum, in fact, is very small and simple. Its substance chiefly shows muscular fibres running across its short diameter, *i. e.* in the longitudinal axis of the body of the worm. Outside of this is a layer of much less diameter, which suggests a subcuticular layer. The simplicity and small size of the rostellum is so far like that of *Tenia saginata*, as figured and described by Leuckart†. It is, perhaps, more to the point to compare the rostellum of the present species with that of more nearly related forms.

Within the genus *Cotugnia* itself the rostellum appears to be usually large. In structure that of *C. collini* is said by Fuhrmann to resemble that of a species of *Davainea*. There are, however, in *Davainea*, as Fuhrmann himself has pointed out‡, considerable differences among the species. There is, however, a remarkable likeness between the present species of *Cotugnia* and *Ophryocotyle insignis*, which may well be of significance. This latter Cestode has, in the first place, a lens-shaped rostellum proper, which, as Lühe has pointed out§, is at least often characteristic of *Davainea*. That is much the same form as I figure here in *Cotugnia margareta*, where, however, it is more cup-shaped and thus sucker-like.

Lühe, however, speaks of the rostellum of *Davainea struthionis* as having a very short antero-posterior diameter and as being concave anteriorly, thus approximating in shape to a sucker. I did not, however, find this to be the case with a species of *Davainea* from *Struthio masaiicus*, which is very probably identical

* Centralbl. f. Bakt. u. Paras. xlv. 1909, p. 121, fig. 38.

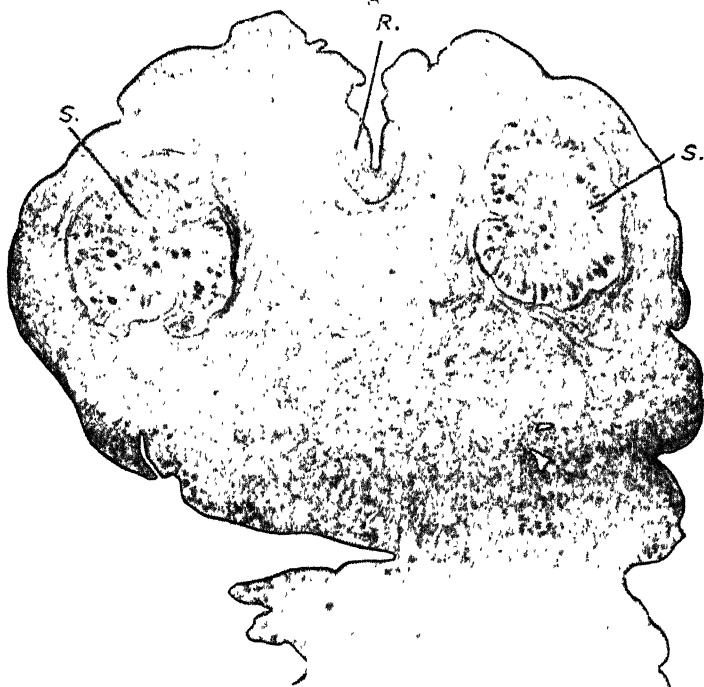
† 'The Parasites of Man' (Engl. trans. by Hoyle), Edinb. 1886, p. 435, fig. 217.

‡ Cf. e.g. in Centralbl. Bakt. u. Paras. xlv. fig. 10, p. 101 & fig. 24, p. 113.

§ Zool. Anz. Bd. xvii. 1894, p. 280.

with *Davainea struthionis* *. The rostellum proper and neighbouring structures of *Ophryocotyle insignis*, with which I am about to compare the corresponding structures of *Cotugnia margareta*, were thus described by Fuhrmann †:—"Das muskulöse Rostellum ist sehr weit vorstülplbar, wobei es der vordere Teil der Skolex ist, der den grössten Teil des mächtigen scheitelständigen Haftorganes darstellt." The figure given by Fuhrmann ‡ of a longitudinal section through the entire "Haftorgane" (and the rest of the scolex) agrees, as will be seen, very closely with the

Text-figure 1.

Longitudinal section through scolex of *Cotugnia margareta*.

R. rostellum, in which the hooks are not shown. S. suckers.

annexed drawing (text-fig. 1) of the same region of *Cotugnia margareta*. The folded apical region of the scolex is present in both, and there is an evident contrast in this with the conditions observable in a congener of my species, viz. *Cotugnia polyacantha*—which latter species appears to resemble more closely various species of *Davainea* § in having a clear-cut and smooth region of

* "On *Tenia struthionis* (Parona) and allied Forms," P. Z. S. 1915, p. 589.

† "Neue Davaineiden," Centralbl. Bakt. u. Paras. xlix. p. 94.

‡ *Loc. cit.* p. 95, fig. 1.

§ P. Z. S. 1915, p. 592, text-fig. 1.

the scolex surrounding the rostellum proper. A highly characteristic feature of the genus *Cotugnia* is emphasised by Fuhrmann in words and in several drawings. This is the presence of several layers of longitudinal muscles, each of which is divided from the neighbouring layer by transverse fibres. There is, in addition, the usual transverse layer bounding the medullary region of the proglottid on the outside. This, as Fuhrmann has remarked, is a point of likeness to the Acoleidæ, and, I may add, to the remarkable genus *Dasyurotenia*, lately described by myself*. The number of layers of longitudinal bundles is not, according to Fuhrmann, the same for all species of *Cotugnia*. In a general way, my examination of *Cotugnia margareta* enables me to confirm Fuhrmann. But my new species shows certain important differences. In the first place, the aspect of the worm is thin and delicate, which argues a feeble longitudinal musculature; and this is proved to be a fact by transverse and longitudinal sections. The cortical layer, if this layer is to be regarded as extending inwards so as to include all of the longitudinal muscle-bundles, is in the posterior region of the body of rather less diameter than the medullary layer. Anteriorly it is, on the other hand, rather greater. I throw some doubt upon this, the customary delimitation of the cortical and medullary layers, because I cannot find a distinct layer or even single line of transverse-fibres separating the inner layer of longitudinal bundles from the medulla. Such a layer is, however, figured by Fuhrmann†. Here and there I do find a single fibre in this situation which may be traced for some distance; but there is certainly no continuous layer. The innermost layer of longitudinal muscles consists of a single row of bundles which are placed at unequal distances from each other and are of unequal sizes, though for the most part much larger than the bundles belonging to this system which occur more superficially. In other species it would appear that this inner layer of bundles consists of more than one row.

Outside of this inner row of bundles there is an area of rather greater width which is sparsely traversed by transverse fibres, between which lie occasionally here and there a single longitudinal fibre or two or three together—they are not sufficiently numerous to be described as forming a row or layer; there are in this region no dense rows such as are figured by Fuhrmann in other species of *Cotugnia*. Outside of this again is the outer row of bundles. These are also irregular in the number of fibres which each bundle contains, and in the distance separating individual bundles. They are, however, on the whole, considerably smaller than the bundles of the innermost layer and lie closer together. Between this layer and the subcuticular layer are a few longitudinal fibres irregularly arranged and sometimes associated two or three together. Transverse fibres

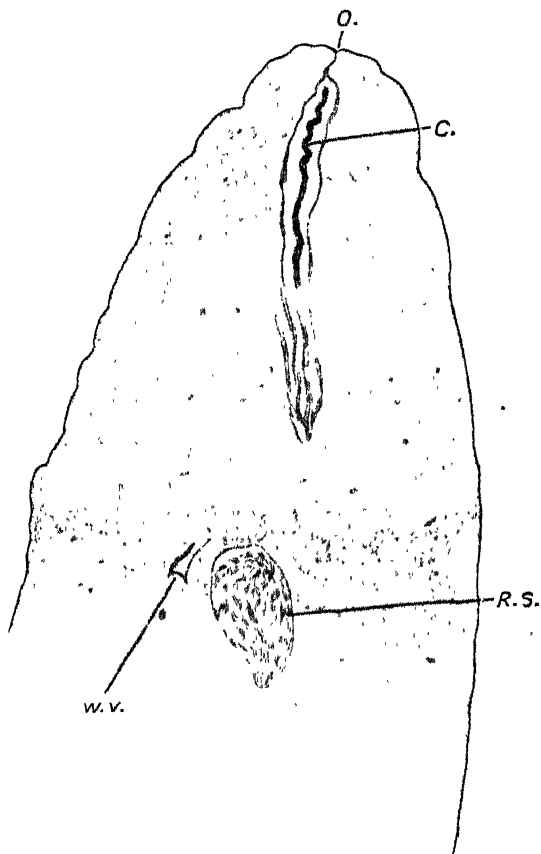
* P. Z. S. 1912, p. 686, text-fig. 98.

† *Loc. cit.* p. 119, fig. 37 & p. 121, fig. 39.

occur to the outside of the outer layer of bundles: but the subcuticular layer is not divided off from the rest of the cortex by any such fibres.

As to the *water-vascular tubes* the larger ventral vessel lies beneath and to the inside of the very small dorsal tube.

Text-figure 2.



Cirrus-sac of *Cotugnia margareta*.

C. cirrus lying within the elongated cirrus-sac. R.S. receptaculum seminis.

W.V. ventral water-vascular tube. O. orifice of cirrus-sac.

Double generative organs characterize this as they¹ do other species of the genus *Cotugnia*. Upon some of these organs I have notes to offer. There is hardly any *genital cloaca* (text-fig. 2); rather there appears to be a kind of plug of soft tissue which blocks the end of the cirrus-sac and the vagina, and can be pushed aside

when the former is extruded. The *cirrus-sac* is short, in that it extends only to the nerve-cord and not as far as to the dorsal and more external of the water-vascular tubes. It appears, however, to be long, because it is thin and with thinnish walls. The *vas deferens* is coiled and the coil lies partly in the cortex. The *vagina* ends in a dilated receptaculum seminis; but this species differs from the other described in the present paper in that the narrow region into which the vagina usually contracts before entering the receptaculum is quite absent. If there be a rudiment of this narrow region it must be at the very point of opening into the receptaculum.

Text-figure 3.



Section (horizontal) through two adjacent segments of *Cotugnia margareta*, showing the embryos scattered through the medullary parenchyma.

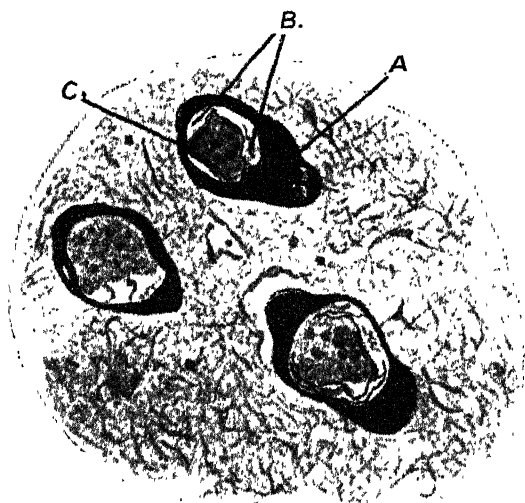
E. embryos. *E'* spaces from which an embryo has fallen out.

A very important character of the genus *Cotugnia* has not been illustrated by figures in previous accounts*, though it is known and used in the definition of the genus. As, however, there is no particular description, and merely the bare statement

* The illustration given by Baczyńska (*Études anatomiques et histologiques sur quelques nouvelles espèces de Cestodes d'oiseaux*. Neuchâtel, 1914, p. 203, fig. 32) is only diagrammatic.

in various definitions, it is so far not clear what the asserted implantation singly of the ripe embryos means. The examination of mature segments allows me to clear up this matter as to the main facts of classificatory importance, at any rate. In comparing these conditions with those already referred to in *Linstowia* there is at first sight some difference in general appearance, which is really due to the laxity of the ground-tissue of *Linstowia*, as compared with the denser medullary tissue of *Cotugnia*. But there is no morphological difference that I can detect. In both the embryos are scattered not very closely (text-fig. 3) through the medullary parenchyma and extend into the cortex. Each

Text-figure 4.



A more highly magnified representation of the embryos of *Cotugnia margarita*.

A. the thick outer shell. B. the indistinct middle shell. C. the inner shell immediately surrounding the embryo.

embryo fits its cavity completely, and I have never seen more than one lying in one space of the parenchyma. This cavity, moreover, has no definite walls of its own. The uterus in younger stages consists of scattered spaces, in each of which may lie several ova, though sometimes only one. The uterus of this Davaineid seems, therefore, to be similar to that of *Linstowia*. The fully ripe embryos are surrounded by three eggshells (text-fig. 4). The outermost is very thick and often locally thickened to form boss-like prominences which may be even narrow and prolonged. The embryo itself is immediately encircled by a thin shell, and between the two a third shell is often to be detected.



MENPES PRFSS WATFORD

J. M. Fawcett, del.

HETEROCERA FROM BRITISH EAST AFRICA.

33. Notes on a Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911-13. By Lt.-Col. J. M. FAWCETT*.

[Received September 27, 1916; Read November 21, 1916.]

(Plate I. †)

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In my former memoir on this subject (P. Z. S. 1915, p. 91) I mentioned that there were a good many species of the Feather Collection which still remained to be examined, and that I hoped to be able to give in another memoir the result of my enquiries into some of them. This I propose to do in the present paper, but, owing to pressure of space in the forthcoming number of P. Z. S., I am only able to deal with a certain percentage of the material in my possession. Meanwhile, a most interesting paper has been published by Professor Poulton (P. Z. S. 1916, p. 91), dealing with Mr. Feather's Collection in Somaliland, in which a large number of new species are described,

* Communicated by the SECRETARY.

† For explanation of the Plate see p. 737.

some of which I also find in the Feather Collection from B. E. Africa, a circumstance which is accounted for by the contiguity of the two districts. The forms represented in both collections are mostly those characteristic of the drier steppes, as was to be expected, owing to the very dry climate of Somaliland.

The insects recorded in this memoir were, I understand, almost entirely taken at light on wet nights, the great majority of them at Kedai and Masonguleni. I have already given the approximate elevation of these places in my former paper on this subject, but it may be as well to repeat it here:—

- (1) Kedai, British East Africa. Altitude 2500 feet, 120 miles from the coast.
- (2) Masonguleni, ditto. Altitude 3000 feet, 182 miles up Uganda Railway.

Practically all the captures were made in the months of November, December, January, March, April, and a few in June. It is curious that I have no records for the other months of the year. Perhaps the months mentioned are the rainy seasons of the year. A record of the rainfall and temperature at Kedai would have been most interesting, and I regret that I cannot supply it.

Out of 124 forms dealt with in this paper, 45 appear to be new, so far as I have been able to ascertain, not having had access to foreign literature on the subject, and this seems a large proportion. Some of the described forms have not previously been recorded from Africa, and others are only represented by the type-specimen in the B. M. Collection.

My friend Lady Colville made a fine collection of lepidoptera at Meru, but she mainly devoted herself to butterflies, with a stray moth or two thrown in; it is therefore remarkable that I should have found some undescribed forms amongst these solitary specimens, and it shows what can be done in this region by anyone who will really take up collecting there and work at it.

The numbers prefixed to the names of species carry on my previous record on the subject in P. Z. S. 1915, and thus start at 125.

In this memoir, B. M. stands for British Museum, and C. L. P. for Hampson's 'Catalogue of the Lepidoptera Phalaenæ.'

The figures have been drawn and painted by myself to exact size. I have not had space to figure all the new forms described, but I hope to do so in a future paper.

HETEROCEA.

Family AMATIDÆ.

125. *APISA CANESCENS* Walker, Cat. iv. p. 917 (1855).

Habitat. Masonguleni, 25th June, 1911, 1 ♀; Kedai, 5th Jan. 1913, 1 ♂; Kisumu, Lake Albert, 19th June, 1911, 1 ♂.

The above specimens are smaller, the antennæ of the males less highly pectinated than in a specimen in my collection from Natal. The specimen from Kisanai is white, the others hyaline, diffused with fuscous. Also recorded from Somaliland.

Family ARCTIADÆ.

Subfamily ARCTIANÆ.

126. *ESTIGMENE GRISEATA* Hampson, P. Z. S. 1916, p. 103.

Habitat. Kedai, 30th Nov. 1912, 1 ♀.

Described from Somaliland. Agrees fairly well with Hampson's figure, but is yellow, and has no marginal spots on fore wing.

127. *PERICALLIA HECATE*, sp. n. (Pl. I. fig. 19.)

Description.—♂. Head and thorax pale brown. Abdomen scarlet above, with transverse black dorsal stripes on the somites; yellow on the underside, with a lateral row of black spots between the red and yellow areas. Legs with tibiæ red, tarsi black and ochreous. Fore wing pale brown covered by various wavy lines composed of fuscous irroration; a black spot at end of cell. Subbasal, antemedial, and medial lines indistinct, excurved on median nervure. Postmedial and submarginal lines crenulate, angled outwards between the veins. A series of indistinct marginal black spots. Hind wing pale yellow, almost transparent basally; a black spot above end of cell between veins 5 and 6, and a dentate discal line from vein 4 almost to inner margin. Three submarginal black patches, viz., one at angle, one, larger, on each side of vein 2, and one on each side of vein 5. Cilia of hind wing yellow, of fore wing brown.

Underside of both wings pale yellow, almost hyaline basally, with the markings of the upperside reproduced.

Habitat. Kedai, 29th Nov. 1911. Exp. 50 mm.

This form is nearest to *P. nephelistis* Hampson, from which it differs in the postmedial and subterminal lines of the fore wing being crenulate, and not broken up into spots, as in *nephelistis*.

128. *SECUSIO STRIGATA* Walker, Cat. ii. p. 559 (1854).

Habitat. Masongaleni, 6th and 9th June, 1911, 1 ♂, 1 ♀.

129. *LACYDES GRACILIS* Butler, P. Z. S. 1898, p. 417, pl. xxxii. fig. 4.

Habitat. Kedai, 12th Jan. 1912, 1 ♀.

Subfamily NYCTEMERIDÆ.

130. *DEILEMERA GLAUCE*, sp. n. (Pl. I. fig. 11.)

Description.—♀. Head and thorax bluish grey, with black markings on the tegulae. Abdomen blue-grey, with black transverse stripes at the junction of the somites and a dorsal and

lateral row of black spots; the anal somite pale yellow. Fore wing hyaline, dusted with fuscous atoms, with a broad sub-terminal brown band, excurved from before apex of cell to near tornal angle. Hind wing hyaline white, with greenish iridescence in certain lights, with a broad fuscous marginal band, excurved between veins 3 and 5, and recurved on vein 2. Cilia fuscous. Underside similar to upperside.

Habitat. Meru, taken by Lady Colville. Exp. 44 mm.

This form is nearest to *D. fallax* Holland.

131. *DIOTA FASCIATA* Annivillius.

Habitat. Msala, B. E. Africa, Nov. 1904, 1 ♂; Kedai, 13th Jan. 1912, 1 ♂; Masongaleni, 25th and 30th April, 1911; 6th June, 1 ♀, 2 ♂.

Family AGARISTIDÆ.

132. *ÆGOCERA BREVIVITTA* Hampson, C. L. P. iii. p. 600 (1901).

Habitat. Masongaleni, 25th Dec. 1911, 1 ♂.

Also recorded from Somaliland.

Family NOCTUIDÆ.

Subfamily AGROTINÆ.

133. *TIMORA FISSIFASCIA* Hampson, C. L. P. iv. p. 110 (1903).

Hab. Kedai, 12th Dec. 1911, 1 ♂.

134. *TIMORA LEUCOSTICTA* Hampson, Ann. S. Afr. Mus. ii. p. 256 (1902).

Habitat. Masongaleni, 25th March, 1 ♀; 30th April, 1 ♂; 25th Sept., 1 ♂, 1 ♀; 25th Dec. 1911, 1 ♂.

Subfamily HADENINÆ.

135. *ODONTESTRA ALBIVITTA* Hampson, C. L. P. v. p. 206, pl. lxxxiv. fig. 6 (1905).

Habitat. Kedai, 26th Nov. 1911, 1 ♂.

Subfamily ACRONYCTINÆ.

136. *ATHETIS HORUS*, sp. n. (Pl. I. fig. 36.)

Description.—♂. Head, thorax, and abdomen pale ochreous; palpi dark brown. Fore wing ochreous; antemedial and post-medial lines red-brown, starting from red-brown fasciæ on the costa and continuing as interrupted and indistinct waved lines to the inner margin. A red-brown submarginal band from apex, incurved between veins 4 and 6, and then straight to a point just before tornal angle. Inside this band is an irregular black submarginal line, also from apex, and also incurved on vein 4,

and excurved to the margin, which it meets below vein 3; beyond this line the marginal area is paler. Hind wing ochreous, with a red-brown submarginal band, the inner edge of which runs straight from costa before apex to anal angle. Cilia brown. Underside pale ochreous.

Habitat. Kedai, 10th July, 1912, 1 ♂; 18th Nov. 1911, 1 ♂. Exp. 30 mm.

137. *ATHETIS PENTHEUS*, sp. n. (Pl. I. fig. 27.)

Description.—♂. Head, palpi, and tegulae red-brown; thorax yellow, abdomen ochreous. Fore wing yellow, a red-brown spot on costa before apex, and a black point at end of cell; a red-brown submarginal band from apex to near tornal angle, in which is a row of white spots on the veins. Hind wing pale ochreous, with a pale fuscous submarginal band, in which is a marginal row of whitish spots. Cilia pale red-brown. Underside pale red-brown except inner margin of fore wing below vein 1 and inner margin of hind wing, which are pale ochreous.

Habitat. Kedai, 12th April, 1912, 1 ♂. Exp. 24 mm.

Subfamily SARROTHRIPINÆ.

138. *GIAURA ASTARTE*, sp. n. (Pl. I. fig. 6.)

Description.—♂. Head and thorax grey, antennae fuscous, abdomen pale ochreous. Fore wing with the basal area grey, and on it a red-brown irregular spot between costa and submedian fold, defined outwardly by an irregular black line. Antemedial line black, irregular. Medial area of wing brown, darkest inwardly. An elongated grey patch along the costa to before apex, on which are placed three costal black strigæ. The post-medial line defines the inner edge of this spot, and runs sharply oblique outwardly to vein 4, is incurved on vein 2, and then straight to inner margin, being defined outwardly by a white line below vein 4. Subterminal area darker brown, on which is placed a grey spot, dentate outwardly on veins 2 and 3. Margin greyish, with a black terminal line. Hind wing white, with a narrow fuscous border from apex to vein 2, with the outer ends of the veins dark brown; a dark marginal line. Cilia of both wings white. Underside of fore wing pale fuscous, of hind wing as on upperside, with an indistinct fuscous spot on middle of costa.

Habitat. Meru, B. E. Africa. Taken by Lady Colville.

This form is nearest to *Giaura minor* Hmps., from Ceylon. It is quite a differently coloured insect from *G. leucotis* Hmps., from B. E. Africa, which is, perhaps, nearest in structure.

139. *RISOBA OBSTRUCTA* Moore, P. Z. S. 1881. p. 328.

Habitat. Kedai, 27th Nov. 1912, 1 ♂.

The specimens in the B. M. Collection are all from India.

Subfamily ERASTRIANÆ.

140. *TARACHE PSALIPHORA* Hampson, C. L. P. x. p. 781, pl. clxxiii. fig. 21.

Habitat. Kedai, 1st Jan. 1912, 1 ♂; Masongaleni, 19th May, 1911, 1 ♀.

The Masongaleni specimen has pinkish ochreous hind wings, the Kedai specimen has white hind wings with a narrow fuscous border. Only one specimen in B. M. Collection.

141. *TARACHE OPALINOIDES* Guen. Noct. ii. p. 219 (1852).

Habitat. Kedai, 28th Nov. 1911, 1 ♂; Masongaleni, 25th May, 1911, 2 ♀.

142. *TARACHE UMBRIGERA* Felder, Reise Nov. pl. cviii. fig. 34 (1874).

Habitat. Kedai, 15th Nov. 1912, 1 ♂; 24th Nov. 1911, 1 ♂.

143. *EUBLEMMA ADMOTA* Felder, Reise Nov. pl. cviii. fig. 31 (1874).

Habitat. Masongaleni, 18th May, 1 ♂; 6th June, 1911, 1 ♀.

144. *AMYNA OCTO* Guen. Noct. i. p. 233 (1852).

Habitat. Masongaleni, 1st March, 1912, 1 ♂; 7th June, 1 ♀.

145. *AMYNA PUNCTUM* Fabr. Ent. Syst. iii. 2, p. 34 (1794).

Habitat. Kedai, 15th Dec. 1912, 2 ♂.

Subfamily ACONTIANÆ.

146. *MAURILIA ARCUATA* Walker, Cat. xii. p. 779 (1857).

Habitat. Kedai, 4th Jan. 1912, 1 ♂.

147. *ACONTIA MALVÆ* Esper, Schmett. iv. (2) p. 63, pl. cxev. fig. 4 (1796).

Habitat. Kedai, 25th Nov. 1911, 2 ♂; 9th Jan. 1912, 1 ♂. Masongaleni, 25th Dec. 1911, 1 ♂.

Recorded by Hampson from Somaliland as *A. albago* Fabr.

148. *LEOCYMA CANDACE*, sp. n.

Description.—♂. Head and thorax pale yellow, abdomen ochreous; antennæ pale brownish white. Fore wing pale yellow with a few red-brown points. No antemedial line. A pale reniform whitish spot surrounded by a narrow indistinct red-brown line in submedian interspace. Subterminal area red-brown, darkest inwardly, with a pale purplish band from costa to tornal angle inside it. The inner edge of this red-brown area is much more incurved than in *L. camilla* Druce, being inwardly oblique from costa to vein 7, then widely incurved to vein 3, and

from that point straight to inner margin before tornus. Hind wing semihyaline white, ochreous along the costal margin to apex.

This form is clearly a connecting-link between *camilla*, on the one hand, which it resembles in the outer red-brown area, and *discophora* Hampsn., on the other, which it resembles in having a discal spot, which is absent in *camilla*.

Habitat. Kedai, 18th Nov. 1911, 1 ♂. Exp. 30 mm.

I hope to figure this form in a subsequent paper.

Subfamily EUTELIANÆ.

149. *EUTELIA DISCISTRIGA* Walker, Cat. xxxiii. p. 823 (1865).

Habitat. Kedai, 30th Dec. 1911, 2 ♂; 1st to 12th Jan. 1912, 4 ♂; 5th Jan. 1912, 1 ♀.

Subfamily GONOPTERINÆ.

150. *ANOMIS SABULIFERA* Guen. Noct. ii. p. 404 (1852).

Habitat. Kedai, 1912, 1st Jan., 1 ♀; 5th Jan., 1 ♀; 8th Jan., 1 ♀; 13th Jan., 1 ♂; 12th April, 1 ♂; 19th Dec., 1 ♀. 1913, 5th Jan., 1 ♂.

Very variable. Some of the specimens agree with the type of *propinqua* Butler, from Aden, and others are typical *sabulifera*, with black suffusion between the postmedial and subterminal lines.

Subfamily CATOCALINÆ.

151. *AUDEA MELANOPLAGA* Hampson, Ann. S. Afr. Mus. ii. p. 328 (1902).

Habitat. Masongaleni, 19th May, 1911, 1 ♀.

152. *CTENUSA RECTILINEA*, sp. n.

Description.—♀. Head, thorax, and abdomen ochreous; tegulæ dark red-brown, antennæ ochreous. Fore wing ochreous, irrorated with pale pinkish brown, the terminal area suffused with the same colour; antemedial line obsolete. Reniform pale red-brown, with a red-brown striga on the costa above it. Postmedial line represented by another red-brown striga on the costa, and a row of black points on the veins to inner margin. Subterminal line ochreous, defined on each side by red-brown from costa straight to vein 2, where it is only represented by a pale spot. A series of brown submarginal spots between the veins. Cilia red-brown. Hind wing with base and centre of wing ochreous white; terminal area ochreous, with a series of spots between the veins. Underside of both wings ochreous white, with a subterminal series of dark spots from costa to vein 2 on the fore wing and a small spot at end of cell.

Habitat. Kedai, 14th April, 1912, 1 ♀. Exp. 50 mm.

This form is nearest to *C. curvilinea* Hamps. C. L. P. xii. Proc. Zool. Soc.—1916, No. XLIX.

p. 378 (1913), Ab. 1, from which it differs in the absence of ante- and postmedial lines, and in the subterminal line being straight from costa to vein 2, instead of curved to tornus. It could not be described as "curvilinea."

Form 2. PSAMATHA, nov. (Pl. I. fig. 21.)

Description.—♀. Similar to *rectilinea*, but fore wing pale ochreous throughout, with only the red-brown strigæ on the costa, and the reniform faintly indicated by red. The terminal area is not suffused with red-brown, and the subterminal line is straight and is only faintly defined by that colour.

Habitat. Kedai, 29th March, 1912, 1 ♀. Exp. 51 mm.

153. ANUA TETTFENSIS Hopff. König. Akad. Wissen. 1857, p. 422.

Habitat. Masongaleni, 8th June, 1911, 1 ♂.

154. EUPHUSA HARMONICA Hampsn. Ann. S. Afr. Mus. ii. p. 335 (1902).

Habitat. Kedai, 25th Nov. 1911, 1 ♂, 2 ♀; 5th March, 1912, 1 ♀; 17th April, 1912, 1 ♀; 24th Nov. 1912, 1 ♂.

This seems a very variable species; all the specimens have the medial area suffused with dark brown before the postmedial line, but the extent of the suffusion is variable in breadth; two specimens taken on 24th and 25th Nov. have the band very narrow, and the antemedial line and rufous suffusion before it obsolete. The March and April specimens are normal.

155. EUPHUSA HERMIONE, sp. n. (Pl. I. fig. 3.)

Description.—♂. Head, thorax, and abdomen pale ochreous. Fore wing: basal area pale violet; antemedial line represented by a red-brown striga on the costa, but obsolete below it, inside which is an ochreous band from costa to inner margin. Rest of wing pale violet from antemedial line nearly to outer margin, where it is greyish violet. Postmedial line represented by a short red-brown line, before which is a diffused red-brown costal patch from costa to vein 6; beyond this line a bright ochreous subapical patch. A marginal series of black points between the veins. Cilia ochreous. Hind wing bright ochreous, greyish towards the margin, with distal and subterminal darker bands from costa to anal angle. A dark brown marginal band. Cilia ochreous, with white patches between veins 1 and 2 and 4 and 6. Underside pale ochreous with dark spots at end of cell, and traces of a fine postmedial line.

Form 2. OCHREATA, nov.

Similar to *hermione* in size, shape, and markings, but with the pale violet replaced by pale ochreous beyond the antemedial line, up to the subterminal line (which in this form is clearly defined

by bright ochreous). Subterminal area of hind wing in some specimens with a broad fuscous band, inwardly much diffused. Underside of fore wing with diffused fuscous subterminal band.

Habitat. HERMIONE, Kedai, 1911, 9th Nov., 1 ♂, 25th Nov., 1 ♂ (type); 1912, 9th March, 2 ♂, 15th March, 2 ♂. Masongaleni, 1911, 25th April, 1 ♂.

OCHREATA, Kedai, 1911, 24th Nov., 3 ♂ (incl. type). Masongaleni, 1911, 28th March, 1 ♀, 2nd April, 1 ♀.

Exp. 38 mm.

156. GRAMMODES STOLIDA Fabricius, Syst. Ent. p. 599 (1775).

Habitat. Kedai, 12th Dec. 1911, 1 ♂.

157. REMIGIODES REMIGINA Mabille, C. R. Soc. Ent. Belg. xxviii. p. exci. (1884).

Habitat. Kedai, 12th Dec. 1911, 1 ♀. Masongaleni, 14th May, 1911, 1 ♂; 25th Nov. 1911, 1 ♂ (the last is a very black specimen).

158. PERICYMA UMBRINA Guen. Noct. iii. p. 4 (1852).

Habitat. Kedai, 10th Dec. 1912, 1 ♂. Hitherto only recorded from India.

159. CORTYTA REMIGIANA Hampson, C. L. P. xii. p. 312 (1913).

Habitat. Kedai, 24th Nov. 1911, 1 ♀; 28th Nov., 1 ♂. 4th Jan. 1913, 1 ♂.

160. CORTYTA BALNEARIA Distant, A. M. N. H. (7) i. p. 228 (1898).

Habitat. Kedai, 25th Dec. 1911, 1 ♀.

Hitherto recorded only from the Transvaal and Mashonaland.

161. CORTYTA VETUSTA Walker, Cat. xxxiii. p. 875 (1865).

Habitat. Kedai, 12th Nov. 1911, 1 ♀.

162. CORTYTA MINYAS, sp. n.

Description.—♂ ♀. Head and thorax greyish ochreous. Abdomen ochreous. Fore wing: basal area pale ferruginous; subbasal line represented by an indistinct black striga from costa to vein 1. Antemedial line black and waved, with a bright ferruginous band inside it on the basal area. Medial area between ante- and post-medial lines grey, with indistinct waved bands of fuscous irroration. Reniform ochreous indistinctly defined. Postmedial line black, outwardly oblique below costa, sharply angled outwardly at veins 6, 4, and 3, and inwardly on discal fold and interspace 2, and thence straight to inner margin. Subterminal area pale ferruginous, with two fuscous subapical spots between veins 6, 7, and 8 in the interspaces, one between veins 3 and 4, and one on inner margin before tornus. Two diffused grey subterminal patches between

veins 6 and 4 and 3 and 1. A fine crenulate black terminal line. Cilia of both wings ochreous.

Hind wing bright ochreous, the terminal half with very indistinct diffused brown striae between veins 4 and 2, and on vein 1. An interrupted terminal line of black lunules. Underside pale ochreous; a dark reniform annulus at end of cell, obsolete in some specimens.

Habitat. Masongaleni, 31st March, 1911, 1 ♀. Kedai, 29th Dec. 1912, 1 ♂. Exp. 30-34 mm.

Form 2. GRISEACEA, nov.

Differs from *minyas* in the whole of the fore wing beyond the antemedial line being grey, with a subterminal ferruginous irregular band; brightest below apex. Otherwise as in that species on upperside; underside white striated with fuscous on costal and apical areas; a black spot at end of cell.

Habitat. Kedai, 15th Dec. 1911, 1 ♀; 15th Jan. 1912, 1 ♀. Exp. 30 mm.

These forms are clearly intermediate between *C. dispar* Püng., from Palestine, on the one hand, and *C. fasciolata* Warr., from the Sudan, on the other.

163. *CORTYTA FASCIOLATA* Warr. Nov. Zool. xii. p. 24, pl. iv. figs. 11, 21 (1905).

Habitat. Kedai, 5th Jan. 1912, 1 ♀.

Subfamily PHYTOMETRINÆ.

164. *PHYTOMETRA CHALCYTES* Esper, Schmett. iv. p. 447, pl. cxli. fig. 3 (1789).

Habitat. Kedai, 7th April, 1912, 1 ♂.

Not recorded from Africa in C. L. P.

Subfamily NOCTUINÆ.

165. *PANDESMA ANYSA* Guen. Noct. ii. p. 439 (1852).

Habitat. Kedai, 25th Nov. 1911, 1 ♂; 7th Jan. 1912, 1 ♀.

Also recorded from Somaliland.

166. *POLYDESMAS COLUTRIX* Geyer.

Habitat. Masongaleni, 25th June, 1911, 1 ♀.

Also recorded from Somaliland.

Genus GALACTOMOIA, nov.

(γαλα=milk, ὁμοίος, α, or=like.)

Type, *G. berenice*, sp. n.

Proboscis aborted; palpi stout, reaching top of head, clothed with thick hair. Eyes large, round; top of head covered with

thick hair. Antennæ of male bipectinated for two-thirds of length, filiform at extremity; female filiform throughout. Thorax clothed with thick hair. Abdomen with paired dorsal tufts on the somites. Legs clothed with long hair on femora and tibiæ, especially the fore legs. Fore wing: apex rounded, the termen crenulate. Veins 3, 4, 5 from lower angle of cell, 6 from upper angle. Hind wing: veins 3, 4 from angle of cell, 5 from a little above it, 6 and 7 stalked from upper angle of cell.

167. *GALACTOMOIA BERENICE*, sp. n. (Pl. I. fig. 15.)

Description.—♂. Head and thorax creamy white, tinged with red-brown; palpi red-brown; extremities of tegulæ and patagia dark red-brown. Antennæ red-brown, bipectinated for two-thirds of length, filiform on outer third. Abdomen red-brown except the two anal segments, which are creamy white, and the vertex of the first two on which are two dorsal creamy-white tufts, the remainder of the dorsal tufts red-brown. Fore wing creamy white, basal area dark brown, narrowly on costa, and continued obliquely outward to a point on vein 1, where it is cut by the antemedial line, where it forms an angle before bending downwards to inner margin. Two red-brown patches on the costa, terminated by the antemedial and postmedial lines inwardly. These two lines are obsolescent and only indicated (1) where the antemedial line meets the brown area on vein 1, and (2) where the postmedial line crosses interspaces 1, 4, 5, and 6, where it is indicated by traces of a black line. Hind wing creamy white, with a red-brown spot at end of cell, and another at anal angle, round, and defined above by a blackish spot on inner margin. Cilia white, except below vein 3 on fore wing, where it is red-brown. Underside white, costa ochreous, marked as on upperside, except that the basal spot is absent and there is a spot at the end of cell.

♀ much paler, almost white. The black postmedial line complete, dentate, excurved to points in the interspaces. Hind wing with an indistinct red-brown submarginal line.

Habitat. Masongaleni, 21st March, 1911, 1 ♀. Kumasi, W. Africa, 1 ♂ (*A. Norris*).

The male specimen from Kumasi is a good deal darker in coloration. There is a specimen of this form in the B. M. Collection, but it has not yet received a name.

Genus *GIRIA*, nov.

Type, *G. bibastis*, sp. n.

Proboscis fully developed. Palpi upturned, long, third joint reaching well above vertex of head. Legs with the tibiæ covered with long hair. Abdomen without crests. Antennæ filiform. Fore wing comparatively short; outer margin non-crenulate, excurved to an angle at vein 4; a tuft of long hairs in cell on underside; veins 3, 4 from lower angle of cell, 5 from just above

it, 6 from upper angle; 9, 10 anastomosing with 8 to form the areole. Hind wing: cell half the length of wing; veins 3, 4 from lower angle of cell, 5 from just above it, 6 from upper end of cell, 8 anastomosing with cell near base.

168. *GIRIA BUBASTIS*, sp. n. (Pl. I. fig. 14.)

Description.—♀. Head and thorax red-brown; abdomen reddish ochreous dorsally, underside pale ochreous with a lateral series of black spots. Palpi ochreous, the third joint long, fuscous, with a white spot at extremity. Tibia ochreous, with long hair; tarsi brown banded with ochreous. Fore wing with the space between the base and the postmedial line dark red-brown, the outer area beyond this line ochreous, thickly irrorated with red-brown atoms, on which the ochreous veins show up prominently. A red-brown subapical patch on the costa, outwardly bordered with grey. Two basal dark brown spots defined outwardly by a grey line, one on costa, and one just below it at base of cell. Antemedial line fuscous, defined inwardly by a grey line, waved to inner margin. Stigma represented by a black point; reniform indistinctly defined by a black line. Postmedial line pale ochreous, outwardly oblique to vein 6, then angled sharply inwards and straight to inner margin. Two black spots in submedian interspace close to tornal angle. Cilia red-brown. Hind wing fuscous, darkest towards apex; outer margin and cilia ochreous. Underside pale ochreous, irrorated with black atoms. Fore wing with a large submarginal black patch between veins 2 and 5.

Habitat. Mombasa, 31st March, 1911, 1 ♀. Exp. 46 mm.

This form is not very near to anything I could find in the B. M. Collection; perhaps the nearest is *Plecoptera lucinia* Saalm., from Madagascar.

Genus *TAVETA*, nov.

Type, *T. syrinx*, sp. n.

Proboscis fully developed; palpi upturned, long, third joint reaching well above vertex of head; mid and hind tibiae spined, without long hair. Abdomen with hairy crests on first three segments only. Wings with the outer margin crenulate. Fore wing with a tuft of long hair on underside of cell. Veins 2, 3, 4 from lower angle of cell, 5 almost touching the origin of 4, 6 and 7 from upper angle, 8 and 9 stalked to form the areole. Hind wing: cell one-third the length of wing; veins 2, 3, 4 as in fore wing, 6 and 7 from upper angle of cell, 8 meeting cell close to base.

169. *TAVETA SYRINX*, sp. n. (Pl. I. fig. 13.)

Description.—♂. Head, body, abdomen, and wings bright ferruginous brown; palpi fuscous. Underside of body and legs ochreous. Fore wing striated profusely before antemedial line.

Subbasal line indistinct, incurved below subcostal nervure. Antemedial line a double pale waved line with ferruginous centre from costa to inner margin. Postmedial line fine, black, and dentate, inwardly defined by white, and situated on a prominent black dentate band, strongly incurved below vein 4 to inner margin. A pale whitish subterminal line, dentate on the veins. A terminal series of black spots. Cilia red-brown (both wings). Hind wing striated on basal area. Two parallel black dentate lines across the disc from vein 6 to inner margin, highly angled outwardly between veins 4 and 5, the inner line defined inwardly by white. A subterminal white dentate line and marginal black spots. Underside ochreous, with fuscous irrorations and double fuscous subterminal bands.

Habitat. Kedai, 5th Jan. 1912, 1 ♂; 30th Jan., 1 ♀.

There are four specimens from Nyasaland (unnamed as yet) in the B. M. Collection which are near this species, but they lack the red suffusion and are fuscous black throughout.

170. *PRORUACA RECURRENS* Hampson, Ann S. Afr. Mus. ii. p. 360 (1902).

Habitat. Kedai, 20th Nov. 1912, 1 ♂; 4th March, 1912, 1 ♂.

Only the type-specimen is in the B. M. Collection.

171. *CATEPHIA POLIOCHROA* Hampson, P. Z. S. 1916, p. 130, pl. i. fig. 47, ♀.

Habitat. Kedai, 27th Nov., 1911, 2 ♀.

The above specimens agree practically with the figure of *poliochroa* (which was described from Somaliland) in coloration.

172. *CATEPHIA SCIRAS*, sp. n. (Pl. I. fig. 35.)

Description.—♂. Head, thorax, abdomen, and fore wing light grey. Palpi, pectus, and legs with pinkish suffusion. Antennæ red, ciliated. Fore wing: subbasal line black from costa to vein 1. Antemedial line incurved on subcostal nervure, oblique to submedian fold, then angled inwards at vein 1; before this line there is a black area below median nervure to inner margin. Claviform red-brown, defined by black, and connected at its extremity with postmedial line. Orbicular and reniform whitish defined by black, where they are joined by lines to blackish patches on the costa. The area between the reniform and postmedial line whitish. The postmedial line black, running some distance along subcostal nervure, incurved at discal fold, angled outwards at veins 4 and 3, then incurved to submedian fold, and thence straight to inner margin. Subterminal line angled sharply outwards on veins 7, 6, 4, and 3, then incurved to inner margin, and beyond it a pale yellow tornal spot. Between the postmedial and subterminal lines is a prominent greyish fuscous band almost reaching the former line. A fine waved black terminal line. Cilia grey. Hind wing hyaline white with strong iridescent gloss, cilia white.

♀. Antennæ fuscous. Fore wing similar to that of male, but the ground-colour is greyish brown, and the subterminal band is more prominent and blacker. Hind wing with the terminal area fuscous brown. Underside white; fore wing with brown discoidal spot, a postmedial line to vein 2 and fuscous area beyond it. Costa of both wings irrorated with pinkish.

Habitat. Kedai, 1911, 26th Nov., 1 ♂; 12th Dec., 1 ♂; 25th Nov., 1 ♀. Exp., ♂ 40, ♀ 42 mm.

This form differs from *C. poliochroa* in the male in being much lighter coloured and in having a distinct subterminal fuscous band, and in the hind wing being pure white, without a submarginal band. In the female it differs in having a prominent subterminal fuscous band on fore wing.

I may be wrong in putting these two specimens together as male and female of the same species, but as *poliochroa* was described from a single female specimen, we cannot tell what its male is like. The male of the nearly allied *C. pericyma* Hmps. from Somaliland has a fuscous band to the hind wing, according to the description.

173. *CATEPHIA SOSPITA*, sp. n. (Pl. I. fig. 32.)

Description.—♂. Head, thorax, pectus, and legs grey-brown. Antennæ minutely ciliate. Abdomen ochreous, with raised brown crests on the first three segments. Fore wing brown; subbasal line black, angled inwardly on median nervure, and beyond it an ochreous spot margined with black. Antemedial line black and sinuous to inner margin, and inside it a black shade on inner margin. Claviform represented by an oval brown spot margined with black. Orbicular and reniform white, margined with black, except above. The area between the ante- and postmedial lines is white above vein 2, dark brown below it. Postmedial line black, double, enclosing a red-brown space; it is angled outwardly on veins 5 and 3, and incurved below vein 2 to inner margin. A dark brown subterminal shade angled outwards on veins 7, 6, 4, and 3, and enclosing some grey spots. A fine black marginal line. Cilia grey. Hind wing hyaline white, with a strong iridescent gloss; cilia white. Underside white; fore wing with brown discoidal spot and subterminal shade.

Habitat. Kedai, 27th Nov. 1912, 1 ♂. Exp. 38 mm.

There is nothing very near this form in the B. M. Collection.

174. *CATEPHIA SCYLLA*, sp. n. (Pl. I. fig. 33.)

Description.—♀. Head and thorax dark brown, with some grey hairs on the tegulæ and patagia. Abdomen fuscous. Antennæ filiform; pectus and legs pale fuscous. Fore wing dark brown, irrorated with grey atoms. Subbasal and antemedial lines obsolete. Some black in cell, on which the orbicular and reniform, which are grey, show up prominently. Claviform represented by a red-brown shade, between which and the

reniform is a white spot partly irrorated with ochreous. Post-medial line black, of the usual form in *Catephia*. Subterminal line obsolete, and only represented by some grey spots. A fine black terminal line. Cilia brown and ochreous chequered. Hind wing white, with broad submarginal black band. Underside (both wings) white, with broad submarginal fuscous bands, and a brown discoidal spot on the fore wing.

Habitat. Kedai, 13th Jan. 1912, 1 ♀. Exp. 42 mm.

This form is nearest to *C. iridiocosma* Beth.-Baker, Ab. 2.

175. *CATEPHIA SERAPIS*, sp. n. (Pl. I. fig. 34.)

Description.—♀. Head, thorax, and abdomen fulvous brown; antennæ filiform. Patagia with some grey hairs. Palpi fuscous, pectus and legs whitish. Fore wing fulvous, thickly irrorated with fuscous and grey atoms to the postmedial line. Subbasal and antemedial lines obsolete. Orbicular black with a white ring. Reniform indistinct, defined by an interrupted white line and with a white spot above it on the costa. Between it and the postmedial line is a bright fulvous patch; the post-medial line of the usual *Catephia* form. Beyond this line, the subterminal area is suffused with bright pinkish fulvous. Subterminal band represented by a few brown spots. A fine marginal black line. Cilia ochreous and brown chequered. Hind wing white, with a broad submarginal black band; cilia white. Underside of both wings white, with broad subterminal fuscous bands; fore wing with a black discoidal spot.

Habitat. Kedai, 16th Jan. 1912, 1 ♀. Exp. 32 mm.

This form is nearest to *C. oligomelas* Mab., from Madagascar, which is nearly black and without fulvous suffusion on the fore wing. Of four specimens in the B. M. Collection, three have no white on the hind wing and the fourth hardly any.

176. *CATEPHIA MESONEPHELE* Hampson, P. Z. S. 1916, p. 131, pl. i. fig. 48, ♂.

Habitat. Kedai, 3rd and 16th Jan. 1912, 2 ♂.

Described from Somaliland. The Kedai specimens are more fulvous on the disc and much darker below it, perhaps owing to the difference in climate.

177. *CATEPHIA PYRAMIDALIS* Hampson, P. Z. S. 1916, p. 129, pl. i. fig. 45, ♂.

Habitat. Kedai, 26th Nov. 1911, 1 ♂.

The Kedai specimen has an elongated black band from ante- to postmedial lines in interspace 1, which is not shown on the figure.

178. *LYNCESTIS AMPHIX* Cramer, Pap. Exot. ii. pl. cxxxiv. fig. C (1779).

Habitat. Kedai, 25th Nov. 1911, 1 ♂.

179. *LYNCESTIS UNILINEA* Swinhoe, P. Z. S. 1885, p. 452, pl. xxvii. fig. 7.

Habitat. Kedai, 22nd April, 1912, 1 ♂.

At the present time there is only the type-specimen in the B. M. Collection, from Poona, India.

Genus *POPPÆA*, nov.

Type, *P. sabina*, sp. n.

Proboscis absent. Palpi short, not reaching vertex of head. Antennæ minutely ciliate, rather thick; legs moderately clothed with hair; hind legs with two spurs. Thorax covered with thick hair; abdomen with dorsal crests on two basal segments and some long hairs at anal extremity. Fore wing rather narrow, apex rounded, termen evenly curved and crenulate. Veins 3, 4 from lower angle of cell, 5 given off from just below the middle; 6 from upper angle; 7 and 8 stalked, and anastomosing with 9. The whole underside of cell of fore wing filled with a patch of raised scales, which project beyond and below it. Hind wing with cell half the length of wing. Veins 3, 4 from lower angle of cell, 5 from just below centre of apex; 6 and 7 stalked, from upper angle; 8 joining cell about one-third of its length from base.

180. *POPPÆA SABINA*, sp. n. (Pl. 1. fig. 5.)

Description.—♂. Head and tegulae grey; thorax red-brown with a pinkish suffusion. Abdomen pale brown, with some ochreous hairs at anal extremity. Palpi, pectus, and legs suffused with pinkish. Fore wing divided into two longitudinal areas by a prominent black-brown line, which somewhat recalls the line in *Lyncestis unilinea*. The upper area from costa to median nervure and along vein 5 grey, thickly irrorated with dark grey scales along the costa, with some brown stripes on the veins and in the interspaces in the terminal area. A dark brown line along the median nervure, with a fork on vein 2 and continued to the termen along vein 5. The area below this line red-brown with pink suffusion. A black terminal wedge-shaped spot below the apex, and a black terminal line, interrupted at the veins. Cilia red-brown. Hind wing white. Underside: fore wing white, with the costa and sub-apical area pinkish; hind wing white.

Habitat. Kedai, 26th Nov. 1912, 1 ♂. Exp. 40 mm.

181. *PLECOPTERA POLYMORPHA* Hampson. P. Z. S. 1916, p. 134, pl. ii. fig. 3. (Described from Somaliland.)

Form 3. *POLYMNIA*, nov.

Description.—♀. Differs from the figure and description of *polymorpha* in the wings being ochreous (instead of white) and irrorated with red-brown scales. Postmedial line consisting

of two ochreous lines of same shape as in *polymorpha*, divided by a ferruginous line, and defined outwardly by a prominent black line from costa to inner margin, and inwardly by a broad diffused red-brown band. The "fine red-brown terminal line" of *polymorpha* represented in this form by a fuscous inwardly diffused band. Hind wing with the distal and terminal areas suffused with red-brown and much darker than in *polymorpha*.

Habitat. Kedai, 12th Nov. 1911, 1 ♀; 7th April, 1912, 1 ♀. Exp. 34 mm.

182. ANTICARSIA IRRORATA Fabricius.

Habitat. Kedai, 11th April, 1912, 1 ♂. Masongaleni, 5th June, 1911, 1 ♂; 3rd June, 1 ♀.

A very variable species. The Masongaleni specimens are suffused with fuscous.

This genus has until recently been known as *Thermesia* Hübner.

183. BREVIPECTEN CORNUTA Hampson, Ann. S. Afr. Mus. ii. p. 404 (1902).

Habitat. Kedai, 8th Dec. 1912, 1 ♀.

184. BREVIPECTEN CLEARCHUS, sp. n. (Pl. I. fig. 31.)

Description.—♀. Head and thorax greyish ochreous, abdomen ochreous; palpi red-brown above, whitish beneath and at extremity of third joint; pectus and legs whitish. Fore wing greyish ochreous with a pinkish suffusion. Antemedial line outwardly oblique to submedian interspace, where it runs parallel with inner margin to meet the postmedial line. Reniform outwardly indistinct, but defined inwardly by the outer edge of a dark red-brown costal spot. A medial incurved line from below reniform to inner margin. Postmedial line pale, defined by fine black lines, outwardly excurved to vein 5, then recurved to inner margin, and immediately beyond it a dark red-brown subapical spot on the costa, from the outer edge of which arises a straight indistinct subterminal line. A series of black terminal points on the veins. Cilia bright ochreous. Hind wing pale ochreous, darker towards the apex and along the termen to vein 2. Underside pale ochreous, with indistinct postmedial lines and a dark discoidal spot on hind wing.

Habitat. Kedai, 7th April, 1912, 1 ♀; 27th Nov. 1912, 1 ♀. Exp. 32 mm.

Differs from *cornuta* in its larger size, want of pearly irroration, and in the postmedial line not being angled outwardly on vein 4 as in that species.

185. CALPE CERNE, sp. n. (Pl. I. fig. 22.)

Description.—♀. Head and tegulae orange red-brown, the head with some fiery orange crests at base of antennae. Thorax

abdomen, and fore wing mouse-colour, the bands dark brown shot with a coppery iridescence. Costal area dark brown from base to middle, this brown patch extending through base of cell to submedian interspace and being outwardly defined (except along the costa) by the subbasal line; two fine black medial lines. Postmedial line represented by a broad brown band angled outwards at vein 3, from costa to inner margin. Reniform indistinct, defined by a brown line. A double black subterminal line, oblique outwardly from costa to termen below apex, then inwardly oblique to inner margin. These lines are succeeded by a brown shade from vein 6 to tornus. A marginal dark brown line. Cilia greyish. Hind wing fuscous grey. Underside of both wings fuscous with ochreous margins.

Habitat. Kumasi, Ashanti, 1 ♀ (*A. Norris*). Exp. 64 mm.

This form is nearest to *Calpe emarginata* Fabr., from India.

There is one specimen, as yet unnamed, in the B. M. Collection.

Genus LECASIA, nov.

Type, *L. othello*, sp. n.

Proboscis fully developed; palpi long, reaching well above vertex of head, second joint densely scaled; legs without hair, the middle pair with two spurs, the hind pair with three. Antennæ filiform. Fore wing with apex more or less acute, outer margin evenly curved. A tuft of long hairs below base of cell on underside. Abdomen without crests. Veins 3 and 4 from lower end of cell, 5 from just above it; 6 from upper angle; 8 and 9 stalked near apex of wing.

186. LECASIA OTHELLO, sp. n. (Pl. I. fig. 4.)

Description.—♂. Vertex of head, palpi, and tegulae orange-ferruginous; thorax and abdomen fuscous. Both wings fuscous black, thickly irrorated with pale ochreous atoms except immediately before the subterminal line, where the irroration is sparse, giving the appearance of a black subterminal band on the fore wing. Subbasal, ante- and postmedial lines obsolete. Orbicular represented by a minute whitish spot; reniform with a white spot in its lower lobe. Subterminal line represented by an irregular row of seven white spots. Hind wing with faint indications of a subterminal line; cilia fuscous. Underside fuscous irrorated with ochreous.

♀. Larger and much browner in coloration. Postmedial line distinct, angled sharply inwards on vein 3, below the discocellular spot, and thence straight to inner margin. The spots of subterminal line obsolescent and formed into an irregular indistinct ochreous subterminal band. Hind wing with an ochreous subterminal band. Otherwise as in male.

Habitat. Kedai, 19th Nov. 1911, 1 ♂. Durban, Natal, 18th Dec. 1899, 1 ♀. Exp., ♂ 40, ♀ 42 mm.

187. *FODINA PENTAGONALIS* Butler, P.Z.S. 1894, p. 589, pl. xxxvii. fig. 8.

Habitat. Kedai, 28th Nov. 1911, 1 ♀.

Subfamily HYPENIDÆ.

188. *GRACILODES CAFFRA*, Guen.

Habitat. Kedai, 10th July, 1912, 1 ♂.

189. *HYPENA DERASALIS* Guen. Delt. & Pyr. p. 27, pl. iv. fig. 2 (1854).

Habitat. Kedai, 27th and 30th Dec. 1911, 1 ♂, 1 ♀ (grey form); 25th Nov. 1911, and 5th Jan. 1912, 2 ♂ (brown form).

The above four specimens represent two forms—a grey and a brown—which I found to be nearest in markings to *derasalis* Guen. when I was trying to identify them in the British Museum. *Derasalis*, however, is a red form, distinguished by having the oblique mark from the apex ochreous. One of these forms is violet-grey, with the exception of the medial brown triangle; the other is fuscous brown throughout, with very indistinct grey markings. I must reserve them for further examination later on.

Family NOTODONTIDÆ.

190. *PHALERA LAVINIA*, sp. n. (Pl. I. fig. 20.)

Description.—♂ ♀. Head, antennæ, and palpi red-brown; tibiæ with red-brown hairs; tegulæ bright fulvous with brown edges; thorax grey (recalling *bucephala*); abdomen fulvous. Fore wing with the basal area, costa, cell, and apical area grey down to vein 6, the remainder of the wing pale brown. Sub-basal line double, black, starting from two black spots on the costa, excurved to costal nervure, then straight to inner margin. Antemedial line also double and starting from two black spots on the costa (the inner one of which is large and triangular), excurved in discoidal cell, then straight to inner margin. Reniform greyish white, marked by four black points. A line postmedial line starting from a virgula on the costa, highly dentate on the veins. Subterminal line represented by a series of dark brown sagittate marks from below apex, defined outwardly by grey spots. A terminal series of black points between the veins. Hind wing pale fuscous, with an indistinct white distal line; cilia light brown. Underside very pale red-brown, hind wing white towards inner margin.

Habitat. Kedai, 26th Nov. 1912, 1 ♂; 1st Dec. 1911, 1 ♀. Exp., ♂ 40, ♀ 44 mm.

191. *SCRANCIA AMATA*, sp. n. (Pl. I. fig. 28.)

Description.—♂. Vertex of head, thorax, and abdomen ochreous brown; palpi, pectus, and legs white. Fore wing

ochreous brown, the costa and a patch before the apex grey. Subbasal line represented by some black spots. Antemedial line black, excurved to submedian fold, where it is sharply angled inwardly and then straight to inner margin. Reniform white, enclosing a black-lined reniform stigma with a white centre. Postmedial line black, slightly excurved from costa to vein 3; a black terminal line interrupted at the veins. Cilia ochreous. Hind wing pale ochreous, darker towards the termen, with an indistinct distal line. Underside: fore wing pale brown, with some white spots on the costa before apex; hind wing ochreous white, marked as on upperside.

Habitat. Kedai, 13th Jan. 1912, 1 ♂. Exp. 42 mm.

192. *CILADISRA NUBIFERA* Hampson.

Habitat. Kedai, 1911. 23rd Nov., 1 ♀; 26th Nov., 2 ♂; 25th Nov., 1 ♂, 1 ♀; 1912, 12th April, 1 ♀.

I have not seen the description of this insect, but to me it seems to be very variable. Two of the above females have the basal area of fore wing deep black. In the males the basal area is concolorous with the rest of wing.

193. *STAUROPOUS CRITOBULUS*, sp. n. (Pl. I. fig. 12.)

Description.—♂. Head, thorax, and abdomen grey. Antennæ crimson. Fore wing white irrorated with grey atoms, the irroration being thickest in the subterminal area; veins white, marked by prominent black spots. A black basal spot. Antemedial line represented by black spots on the costa, median nervure, and vein 1. Orbicular a large grey spot. Postmedial line represented by black spots on the costa and on veins 6, 5, 4, 3, 2, 1. Beyond this row of spots are two parallel rows of black spots on the same veins. Hind wing white, with a black marginal line from anal angle to vein 1; cilia white. Underside white; fore wing with a black marginal line.

Habitat. Kedai, 25th Nov. 1911, 2 ♂. Exp. 44 mm.

Family GEOMETRIDÆ.

The arrangement of Sir George Hampson, in Faun. Brit. Ind. vol. iii., has been followed here as nearly as possible when dealing with species from a different region.

Subfamily BOARMINÆ.

194. *ACADRA RECTISTRIARIA*, Herr.-Schäff.

Habitat. Teita Hills, 14th May, 1912, 1 ♂.

195. *SEMIOTRISA GRASSILIMBARIA* Mabille.

Habitat. Kedai, 9th June, 1912, 1 ♂.

196. SEMIOTHISA LATARIA Walker.

Habitat. Kedai, 19th Dec. 1911, 1 ♀.

197. SEMIOTHISA OBLIQUILINEATA Warren.

Habitat. Kedai, 18th Nov. 1911, 1 ♀.

198. SEMIOTHISA SEMIALBIDA Prout.

Habitat. Kedai, 17th Dec. 1911, 1 ♀.

199. PERIDELA BERENGARIA, sp. n. (Pl. I. fig. 26.)

Description.—♂. Reddish grey irrorated with fuscous, with a broad postmedial ochreous band striated with fuscous across both wings. Palpi, pectus, legs, and underside of abdomen pale yellow; antennæ pectinated. Fore wing: antemedial line virtually obsolete; an oblique red-brown medial band from costa to inner margin. Hind wing with red-brown antemedial line. A dark red-brown point at end of cell, and red-brown patches at anal angle between veins 3 and 4. Underside pale yellow striated with fuscous, and with medial and subterminal fuscous bands; cilia reddish ochreous.

Habitat. Kelai, 22nd Nov. 1911, 1 ♂; 25th Jan., 1913, 1 ♂ (type). Exp. 42 mm.

This form is nearest to *P. arhoparia* Swinhoe, but differs in the ante- and postmedial lines being obsolete on the fore wing. The November specimen is paler and has only a faint indication of the subterminal band, the other markings being obsolete.

200. PERIDELA NOVARIA, sp. n. (Pl. I. fig. 17.)

Description.—♀. Pale ochreous, irrorated and striated with fuscous. Palpi, pectus, legs, and underside of abdomen pale yellow. Antennæ filiform. Fore wing: antemedial line obsolescent between red-brown spots on costa and inner margin. Reniform defined inwardly by a dark red-brown striga starting from costa. Indications of a postmedial line between veins 3 and 4 and on inner margin. Subterminal line represented by red-brown spots on costa, between veins 3 and 4 and 1 and 2, connected by an obsolescent fuscous band. Hind wing with a fuscous antemedial band and a black point at end of cell. An indistinct fuscous subterminal band with dark red-brown spots between veins 3 and 4 and above anal angle.

Underside pale yellow irrorated and striated with fuscous; an indistinct reddish medial line, which is antemedial in the hind wing; subterminal line fuscous and prominent, enclosing some indistinct grey patches; a black point at end of cell. Cilia ochreous.

Habitat. Kedai, 12th April, 1912, 1 ♀. Exp. 42 mm.

This form is also nearest to *P. arhoparia* Swinhoe, but differs in its paler coloration and in the bands being more or less

obsolescent. These two forms present a somewhat similar facies, but Mr. Prout considers them to be distinct and showing variation in different directions.

201. *TEPHRINA BUTARIA* Swinhoe.

Habitat. Kedai, 29th Dec. 1912, 1 ♂; 14th Dec. 1911, 1 ♀.

202. *TEPHRINA DECRARIA* Walker.

Habitat. Masonguleni, 2nd June, 1911, 1 ♀.

203. *ZAMARADA SECUTARIA* Guen.

Habitat. Kedai, 29th Dec. 1912, 1 ♀; 2nd April, 1911, 1 ♂.
Recorded from Somaliland.

Genus *FULVARIA*, nov.

Type, *Fulvaria striata*, sp. n.

Proboscis minute; palpi hairy; antennæ ciliate for two-thirds of length. Mid tibia with one spur; hind tibia with one proximal and a pair of terminal spurs in female. Fore wing with vein 3 from angle of cell; veins 7, 8, 9, 10 stalked, 11 free. Hind wing with vein 3 from before angle of cell.

Allied to *Hyperythra* Guen., in which the apex of fore wing is acute and outer margin of hind wing crenulate. In this genus the outer margins are evenly curved and apex of fore wing rounded.

204. *FULVARIA STRIATA*, sp. n. (Pl. I. fig. 10.)

Description.—♀. Pale yellow thickly striated with fuscous, and with a pinkish suffusion in certain lights. Fore wing: antemedial line obsolete; a blackish spot at end of cell; postmedial line represented by a broad diffused fuscous band from costa to inner margin. Hind wing with the costal area much paler, a black spot at the end of cell, and the postmedial band narrower and more linear. Cilia with a reddish tinge. Under-side similar to upperside, with the postmedial line more distinct and with pink suffusion beyond it towards apex of fore wing.

Habitat. Kedai, 27th Nov. 1911, 1 ♀. Exp. 34 mm.

205. *GLEORA PROXIMARIA*, subsp. *ALBESCENTS* Prout, Nov. Zool. xxii. 1915, p. 361.

Habitat. Kedai, 25th Nov. 1911, 1 ♂; 20th April, 1912, 1 ♂.
In Faun. Brit. Ind. vol. iii. this genus is placed under *Boarmia*.

206. *BOARMIA PERSE*, sp. n. (Pl. I. fig. 18.)

Description.—♂. Antennæ minutely ciliate for two-thirds of length. Head, thorax, and body ochreous brown. Fore wing bright fulvous; antemedial line black, defined inwardly with

white, excurved to submedian fold, then waved to inner margin. A broad black band at end of cell, below which it becomes indistinct, and is incurved to vein 1. Postmedial line black, outwardly defined with white, straight from costa to vein 4, then incurved to vein 1. Subterminal line represented by a very indistinct row of whitish patches. Hind wing ochreous, whitish on costa and base of wing, fulvous towards anal angle. A black spot at end of cell. A black postmedial line outwardly defined with white, angled outwardly at vein 4, with a dark striga above it from inner margin to vein 2. A fine black terminal line. Underside ochreous, with black discoidal spots on both wings; postmedial line obsolescent, and mostly defined by its white outer margin.

Habitat. Kedai, 1911, 24th Nov., 1 ♂; 15th Dec., 1 ♂. Exp. 34 mm.

207. *BOARMIA SUBALBATA* Warren.

Habitat. Kedai, 1911, 26th Nov., 2 ♂; 1912, 5th Jan., 1 ♂; 13th Jan., 1 ♀; 15th March, 1 ♀; 12th Dec., 1 ♀.

208. *BOARMIA OCTOMACULATA* Warren.

Habitat. Kedai, 15th Jan. 1912, 1 ♀.

209. *GIRPA CIRCUMDATA* Walker.

Habitat. Meru, taken by Lady Colville, 1 ♂.

210. *PITTHEA TRIPLAGIATA* Warren.

Habitat. Mombasa, 30th Oct. 1910, 1 ♂.

Subfamily LARENTIINÆ.

211. *ORTHOLITHA MONOTECTA* Butler.

Habitat. Meru, taken by Lady Colville, 1 ♂.

212. *EUCESTIA NEDDARIA* Swinhoe.

Habitat. Meru, taken by Lady Colville, 1 ♂.

213. *CIDARIA ASTERIA*, sp. n. (Pl. I. fig. 7.)

Description.—♂. Head and thorax red-brown; abdomen ochreous, with transverse fuscous bands on the somites. Fore wing: basal area pale brown up to the antemedial line, which is white. Medial area of wing, between the ante- and postmedial lines, fuscous brown, with an indistinct paler medial band. Postmedial line white, angled outwardly between veins 2 and 3 and 3 and 4. Subterminal area pinkish brown, with a bright fulvous apical patch. An indistinct dentate subterminal line, and a row of submarginal white spots with dark patches inside them. Hind wing ochreous, deepening to fulvous at the termen, with a dark patch at anal angle and brown irroration above it towards

inner margin. Underside coloured the same as upperside, but much paler; subapical area of fore wing bright pink.

Habitat. Meru, taken by Lady Colville, 1 ♀. Exp. 34 mm.

214. *CIDARIA PROCNE*, sp. n. (Pl. I. fig. 8.)

Description.—♂. Head and thorax red-brown; abdomen ochreous, with fine blackish transverse bands on the somites. Fore wing: basal area pale ochreous up to the antemedial line, which is a double white line, evenly curved from costa to inner margin. Medial area of wing between ante- and postmedial lines red-brown. Postmedial line consisting of double white lines angled outwardly between veins 3 and 4, the outer line of which is so broad that it gives the appearance of a broad white band. A dark red-brown subapical patch, followed by a small ochreous apical spot. Terminal area ochreous, with an indistinct row of white spots. Hind wing pale ochreous, with some traces of a postmedial line on the inner margin above anal angle. Underside ochreous; medial area of fore wing fuscous.

Habitat. Meru, taken by Lady Colville, 1 ♂. Exp. 30 mm.

These two forms, which present some analogy to one another, are nearest to *C. molata* Felder.

215. *RHODOMETRA SACRARIA* Linn. Syst. Nat. i. 2, p. 863 (1767).

= *labda* Cramer, Pap. Exot. i. p. 129, pl. clxxvi. fig. D (1777).

Habitat. Kedai, 1912, 15th Jan., 1 ♀ (*sacraria*); 11th March, 1 ♀ (*labda*); 7th March, 1 ♂ (*labda*). Masongaleni, 1st March, 1 ♂ (*labda*); 24th May, 1 ♀ (*sacraria*).

The *sacraria* form has the fore wing ochreous, with a brown band from apex to middle of inner margin; in the *labda* form the wing is pale primrose and the band is crimson.

216. *RHABDOMETRA PLECTARIA* Guen.

Habitat. Meru, taken by Lady Colville, 1 ♂.

217. *CAMPTOGRAMMA NATALATA* Walker.

Habitat. Kedai, 1912, 12th Jan., 1 ♂; 16th Jan., 2 ♀. Masongaleni, 1912, 2nd April, 1 ♂; 14th June, 1 ♀.

Subfamily ACIDALIINÆ.

218. *IDÆA NIOBE*, sp. n.

Description.—♀. Pale ochreous irrorated with fuscous scales. The frons red-brown. Fore wing: antemedial line indistinct, angled outwardly on median nervure. A fuscous striga at end of cell. Postmedial line outwardly oblique to vein 6, thence incurved and irregularly dentate to inner margin. A prominent subterminal line excurved on veins 7 and 6, and thence irregularly dentate to inner margin, with two indistinct diffused

waved bands beyond it. A black marginal line interrupted at the veins; cilia crenulate and ochreous. Hind wing with black point at end of cell, a dentate postmedial line, and two indistinct waved bands beyond it; a dark terminal line; outer margin crenulate; cilia pale ochreous.

Habitat. Masongaleni, 26th June, 1911, 1 ♀. Exp. 26 mm.

This form is nearest to *ignobilis* Warren, from China. It differs from *Craspedia remotata* Guen., from India, in the post-medial and subterminal lines being outwardly oblique to vein 6 in the fore wing, and in the margins being crenulate.

219. *PROBLEPSIS VESTALIS* Butler.

Habitat. Masongaleni, 2nd June, 1911, 1 ♀.

220. *INDUNA ALBIDA* Warren.

Habitat. Kedai, 1912, 4th Jan., 1 ♂; 7th Jan., 1 ♂; 12th April, 1 ♂, 1 ♀; 2nd Dec., 1 ♀.

221. *INDUNA LACTEA* Warren.

Habitat. Masongaleni, 1912, 24th March, 1 ♂; 2nd April, 1 ♂; 25th April, 1 ♂, 1 ♀; 19th May, 1 ♀.

One of the above females represents a variety with very heavily marked bands, which Mr. Prout has never seen before.

222. *TRAMINDA VIRIDARIA* Walker.

Habitat. Masongaleni, 24th May, 1911, 1 ♂; 1st March, 1912, 1 ♀. Kedai, 28th Dec. 1912, 1 ♂.

The May specimen is much smaller than the other two.

Subfamily GEOMETRINÆ.

223. *PRASINOCYMA UNIPUNCTA* Warren.

Habitat. Kedai, 19th Jan. 1912, 1 ♀. Masongaleni, 20th April, 1912, 1 ♂.

224. *HETERORACHIS IDMON*, sp. n. (Pl. I. fig. 9.)

Description.—♂. Bright grass-green. Antennae, palpi, pectus, and legs pinkish ochreous. Fore wing with the costa ochreous, striated with rust-brown. A broad marginal ochreous band highly incurved on vein 2, to vein 1, and then straight to inner margin; on this band there is a row of rust-brown spots between the veins, that between veins 1 and 2 being the largest. Hind wing with the ochreous marginal band broadest in the apical area, the rust-brown spots indistinct except towards anal angle. Underside very pale green, with ochreous margins; cilia ochreous.

Habitat. Kedai, 26th Nov. 1911, 1 ♂. Exp. 26 mm.

This form is nearest to *Heterorachis lunaticargo* Prout, but differs from it in the ochreous border being broader and more irregular and the termen of the hind wing more rounded.

225. *HYPODOXA EREBUSATA* Walker.*Habitat.* Masongaleni, 22nd April, 1911, 1 ♂.

Family SATURNIADÆ.

Genus *CAPENA*, nov.Type, *Capena crenulata* Fawcett, P. Z. S. 1915, p. 103, pl. ii. fig. 27.

Fore wing with the costa almost straight, slightly curved before apex. The apex produced and acute; the outer margin crenulate, highly excised in the interspaces between veins 6, 7, and 8. Hind wing with the costa long, straight, the apex produced. Outer margin more highly crenulate than the fore wing; tornus angulate, inner margin concave. Neuration as in *Andawrelia*.

In my former memoir I described this species under the genus *Ludia* Wallengren, as the only form I could find near it in the British Museum was Hübner's figure of *Heniocha grimmia*. As it is so very different in facies from that and the other species of *Ludia* and *Heniocha*, I consider it best to erect a separate genus for it.

Family ARBELIDÆ.

226. *LEBEDODES NÆVIUS*, sp. n. (Pl. I. fig. 24.)

Description.—♂. Head, tegulae, pectus, and legs brownish grey; thorax dark red-brown; abdomen brownish grey, the three basal somites with brown dorsal tufts or crests. Wings brownish grey thickly striated with pale brown, the striation being more or less circular, enclosing round grey spots. Fore wing with a black wedge-shaped oblique patch below vein 1, from near base to middle of inner margin, that part of the wing immediately above it being pale grey without striation. Hind wing with the striation much paler. A pale brown marginal line; cilia brownish grey. Underside as on upperside, but paler.

Habitat. Koolai, 26th Nov. 1911, 1 ♂. Exp. 38 mm.

This form is nearest to *Lebedodes cossula* Holland, but is much smaller, the striation is thicker, and there are no postmedial lines on the fore wing.

227. *SELAGDIA NARSIS*, sp. n. (Pl. I. fig. 25.)

Description.—♂. Head and thorax ferruginous, pectus and legs paler: legs with the tibiae covered with thick blackish hair. Abdomen ferruginous above, paler underneath, covered with long hair, and with thick dorsal ferruginous crests on the somites, and a thick upturned tuft of hair at the anal extremity.

Fore wing ferruginous, suffused with pink reflections, thickly striated with dark red-brown, the striation being circular and enclosing round ochreous spots. A dark brown patch at end of cell, and near base below median nervure, caused by the striation being blacker and thicker at those points. Cilia red-brown,

chequered with a marginal series of round ochreous spots. Hind wing ochreous, inclining to fulvous along inner margin, with faint traces of striation. Underside of both wings ochreous, striated on and near the costa.

♀. Very similar to male, rather larger, and with the pink suffusion more prominent; legs not so thickly clothed with hair; underside of abdomen pale ochreous with a dark lateral longitudinal streak.

Habitat. Kedai, 8th Dec. 1911, 1 ♀; 15th Jan. 1912, 1 ♂. Exp., ♂ 30, ♀ 36 mm.

This form is nearest to *Selagdia transversa* Holland, from the Gold Coast, but differs from it in the striation being spotted and not streaked, and in there being no fulvous patches.

Family COSSIDÆ.

228. DUOMITUS PINDARUS, sp. n.

Description.—♂. Head, thorax, antennæ, and legs pale red-brown. Thorax and metathorax sprinkled with white hairs; abdomen pale red-brown, with some dorsal crests on three basal somites. Fore wing pale red-brown, the inner area irrorated with black strigæ. A black patch on the costa from base to near middle, extending downwards through the cell to median nervure. Immediately below this patch a prominent deep black band in the shape of a tent-peg (? claviform) runs along median nervure and below vein 2, ending in a quadrilateral black spot between veins 2 and 1, and touching both veins. Below this streak is a white spot with a few striations on it. A long black spot on costa above end of cell, which becomes an indistinct diffused patch between veins 6 and 2. Outer half of cell and costal area above it (between the two black spots) whitish. Some black streaks between the nervures on the subterminal area. Hind wing white, with a narrow fuscous terminal band; cilia fuscous. Underside of fore wing pale fuscous, with some raised white scales at base of cell. Hind wing white, the costa fulvous, no striation.

♀. Larger than male, similarly marked except that the black longitudinal band of the male is divided into two parts by a white spot.

Habitat. Kedai, 25th Nov. 1911, 1 ♂, 1 ♀. Exp., ♂ 40, ♀ 44 mm.

This form is allied to *Duomitus steniptera* Hampson, P.Z.S. 1916, p. 166, described from Somaliland, but differs from it in a good many points, the chief being (1) its larger size, (2) the ground-colour being red-brown, not white, and (3) the presence of the prominent longitudinal black band below the median nervure.

Family LASIOCAMPIDÆ.

229. CHILENA DONALDSONI Holland.

Habitat. Meru, taken by Lady Colville, 1 ♂.

Family PYRALIDÆ.

Subfamily PYRALINÆ.

230. *DATTINIA AURORA*, sp. n. (Pl. I. fig. 29.)

Description.—♂. Antennæ red, bipectinate with long branches to near apex. Head and thorax ochreous yellow, the patagia with red fringes; abdomen ochreous, suffused with pink dorsally. Palpi very long, ochreous above, red beneath; legs ochreous, the tarsi crimson. Fore wing ochreous yellow, the costa crimson at base, with a crimson line running along the subcostal nervure for three-fourths its length. A crimson band along vein 1, and veins 4 and 5 from end of cell to the subterminal area until the end of the bands is in line with a subterminal series of crimson spots on the veins from costa to vein 2. The apex of wing and outer and inner margins defined by a crimson terminal line. Hind wing white, with silvery iridescence, the veins crimson, and a broad inwardly diffused crimson terminal band; cilia ochraceous.

Underside of fore wing ochreous yellow, the veins and margins pale pink. Hind wing ochreous white, the costal area and outer margin diffused with pink.

♀. Antennæ filiform, red. Fore wing, upperside as in male, hind wing crimson, cilia ochreous.

Habitat. Kedai, 1911, 20th Nov., 1 ♂; 24th Nov., 1 ♀; 25th Nov., 3 ♂; 1912, 14th April, 1 ♂. Exp., ♂ 43, ♀ 46 mm.

231. *DATTINIA PERSTRIGATA* Hampson.

D. perstrigata Hampson. P. Z. S. 1916, p. 172, pl. ii. fig. 40, ♂.

Form 2. *TITHONUS*, nov. (Pl. I. fig. 23.)

Description.—♂. Differs from the figure of *perstrigata*, quoted above, in the fore wing being irrorated with pale crimson, with the exception of the costal and apical areas. A thin red line round the apex, a black terminal line on both fore and hind wings interrupted at the veins.

♀. Larger than the expanse given for *perstrigata*, and differing from the female in the B. M. Collection in that the latter has the hind wing and disc of the fore wing fuscous, and no interrupted black marginal line.

In this form the hind wing and cilia are pale pink, the cell of the fore wing more or less white, a prominent black curved line on the submedian fold (which is not mentioned in the description on p. 172), and a black terminal line on both wings as in male; it also exceeds *perstrigata* in size, and is the largest *Dattinia* in British East Africa.

Habitat. Kedai, 1911, 14th Nov., 1 ♀; 20th Nov., 1 ♀; 13th Dec., 1 ♂; 1912, 29th Dec., 1 ♂. Exp., ♂ 40, ♀ 50 mm.

232. *DATTINIA ORION*, sp. n. (Pl. I. fig. 30.)

Description.—♂. Antennæ bipectinate almost to the apex. Head, palpi, thorax, and legs white, irrorated with black atoms. Abdomen ochreous above, white underneath. Fore wing white, irrorated with black atoms; an oblique black band (formed by more intense black irroration) from costa at middle to inner margin at one-third from base of its total length. Two small black spots, one in lower and one in upper angle of cell. A sub-terminal brown band, formed as in the other, straight from costa before apex to vein 4, where it is angled outwardly, and thence oblique to inner margin. Beyond this band the veins are marked with indistinct black streaks; a terminal line of black points; cilia whitish. Hind wing semihyaline white; cilia white.

Underside of fore wing ochreous; a fuscous patch in cell, and a patch of raised scales at base of cell. Hind wing semihyaline white, the costa ochreous.

Habitat. Kedai, 14th Dec. 1911, 1 ♂. Exp. 28 mm.

233. *ANOOSTRA RADIALIS* Hampson.

Habitat. Kedai, 29th Jan. 1912, 1 ♂.

Subfamily PYRAUSTINÆ.

234. *GLYPHODES INDICA* Saund.

Habitat. Kedai, 8th Dec. 1912, 2 ♂.

235. *GLYPHODES SINUATA* Fabricius.

Habitat. Maongalení, 23rd April, 1911, 1 ♂.

236. *ZINCKENIA FASCIALIS* Cramer.

Habitat. Kedai, 25th Nov. 1911, 1 ♂; Maongalení, 29th March, 1912, 1 ♂.

237. *AGATHODES MUSCIVALLIS* Guen.

Habitat. Kedai, 13th Dec. 1911, 1 ♂.

238. *FILODES COSTIVITRALLIS* Guen.

Habitat. Kedai, 8th April, 1911, 1 ♂; 5th June, 1 ♂.

239. *PHLYCTENODES CASTALIS* Warren.

Habitat. Kedai, 16th Nov. 1911, 1 ♂.

240. *MELYNA POLYGONALIS* Hübner.

Habitat. Kedai, 16th March, 1912, 1 ♂.

241. *LYGROPIA AMYNTUSALIS* Walker.

Habitat. Kedai, 8th Dec. 1911, 1 ♂; 9th Jan. 1912, 1 ♀.

242. *LYGROPIA PASITHEA*, sp. n. (Pl. I. fig. 16.)

Description.—♂ ♀. Very pale ochreous yellow. Head and thorax slightly marked with brown; abdomen with some brown

dorsal streaks. Fore wing: base of costa dark brown to antemedial line. Two basal brown spots, one below costa and on inner margin. Antemedial line dark brown, straight to inner margin, where it meets an oblique brown line from the large discocellular reniform mark. Postmedial line straight to vein 2, where it is met by an outwardly oblique line from the discocellular reniform spot. A brown terminal line enlarged to a spot at tornal angle; cilia white.

Inner area of hind wing white. Antemedial line prominent, from a black spot in end of cell to inner margin at middle. Postmedial line angled outwardly at vein 4, and stopping at vein 2, below which there is a dark spot on the brown terminal line.

Underside iridescent white, marked as on upperside, but much fainter.

Habitat. Masongaleni, 1911, 5th Dec., 1 ♂. Kedai, 1911, 13th Dec., 1 ♂; 1912, 4th April, 1 ♀. Exp. 18 mm.

This form differs from *amyntusalis* in its much smaller size and pale coloration. Fore wing without the apical and tornal brown patches; hind wing without the apical patch, and the antemedial line meets the inner margin at middle and is not oblique towards the tornus.

243. *PIONEA NIGRIPUNCTALIS*, sp. n. (Pl. I. fig. 2.)

Description.—♂. Bright yellow. Fore wing angled at apex, but not acute. Costa with a black basal spot, a black antemedial spot, and a black subapical spot. A black spot at end of cell. Hind wing with indications of postmedial and subterminal lines. Underside paler, unmarked except for a black spot at end of cell.

Habitat. Masongaleni, 2nd June, 1911, 1 ♂. Exp. 22 mm.

244. *PIONEA XANTHALIS*, sp. n.

Description.—♂. Bright orange-yellow; fore wing rounded at apex. An indistinct fuscous spot at end of cell, and two on submedian fold, of which one is antemedial and one postmedial. Hind wing paler; the cilia very long and pale ochreous. Underside of fore wing with a fuscous spot at end of cell and a curved postmedial fuscous band. Hind wing unmarked.

Habitat. Kedai, 7th March, 1912, 1 ♂. Exp. 22 mm.

245. *PYRAUSTA INCOLORALIS* Guen.

Habitat. Masongaleni, 8th March, 1911, 1 ♂.

246. *PYRAUSTA STHENIALIS* Hmps. P. Z. S. 1916, p. 176, pl. ii. fig. 47. ♂.

Habitat. Masongaleni, 6th June, 1911, 1 ♀.

Described from Somaliland.

Family *ÆGERIDÆ*.

247. *MELITTIA HÆMATOPIS*, sp. n. (Pl. I. fig. 1.)

Description.—♂. Head red-brown, hairy; antennæ ciliate in

both sexes, much dilated before the tip, which is pointed; palpi brown above, white beneath. Thorax and pectus creamy white: legs brown, the femora, tibiae, and part of the tarsi—especially the hind pair, which are very long—covered with long white hair, mixed with tufts of red and black hairs. Abdomen creamy white, with brown transverse bands at the intersection of the somites, except the two somites nearest the anal extremity, which are entirely brown. A tuft of ferruginous hairs at the extremity. Each somite is decorated with prominent blood-red spots (hence the name *haematopis*), and also with some black spots, all of irregular size and shape.

Fore wing ochreous, the costa, veins, and inner margin red-brown. Some black spots or patches on the basal area, especially at base of inner margin, and a few blood-red scales mixed with them. Cell filled with large blood-red scales, and with a bunch of black scales forming a patch at the apex. Another bunch of black and blood-red scales mixed forms a second patch in the postmedial area. A brown marginal line along the cilia, which are very long and red-brown. Hind wing hyaline, shot with brilliant blue, the veins dark brown; cilia long and red-brown. Underside of fore wing pale fuscous without red scales; hind wing as on upperside.

♀. Similar to male, but a good deal larger.

Habitat. Kedai, 1911, 25th Nov., 2 ♂; 13th Dec., 1 ♀. Exp., ♂ 26–34, ♀ 50 mm.

Considered by Mr. Durrant, who suggested the name "*haematopis*," to be one of the most remarkable forms he has seen.

Family TINEIDÆ.

248. *MELASINA RECONDITA* Durrant, P. Z. S. 1916, p. 181.

Habitat. Kedai, 1911, 19th Nov., 1 ♂.

Another of the forms described recently from Somaliland.

EXPLANATION OF THE PLATE.

Fig.

1. *Melittia haematopis*, ♀.
2. *Pionea nigripunctalis*, ♂.
3. *Euphysa hermonia*, ♂.
4. *Lecasia othello*, ♂.
5. *Poppea sabina*, ♂.
6. *Giaura astarte*, ♂.
7. *Cidaria asteria*, ♂.
8. *Cidaria procne*, ♂.
9. *Heterorachis idmon*, ♂.
10. *Fulcaria striata*, ♂.
11. *Deilemera glauca*, ♀.
12. *Stauropus critobulus*, ♂.
13. *Taveta syrinx*, ♂.
14. *Giria bubastis*, ♂.
15. *Galactomoia herenice*, ♂.
16. *Lygropia pasithea*, ♂.
17. *Peridela novaria*, ♀.
18. *Boarmia perse*, ♂.

Fig.

19. *Pericallia hecate*, ♂.
20. *Phalera lavinia*, ♀.
21. *Ctenusa rectilinea psamatia*, ♀.
22. *Calpe cerne*, ♂.
23. *Dattinia perstrigata tithonus*, ♀.
24. *Lebedodes nævius*, ♂.
25. *Selagdia narses*, ♂.
26. *Peridela berengaria*, ♂.
27. *Athetis pentheus*, ♂.
28. *Serancia amata*, ♂.
29. *Dattinia aurora*, ♂.
30. *Dattinia orion*, ♂.
31. *Brevipecten clearchus*, ♀.
32. *Catephia sospita*, ♂.
33. *Catephia scylla*, ♀.
34. *Catephia serapis*, ♀.
35. *Catephia sciras*, ♂.
36. *Athetis horus*, ♂.

EXHIBITIONS AND NOTICES.

October 24th, 1916.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following report on the Additions made to the Society's Menagerie during the months of May, June, July, August, and September, 1916 :—

MAY.

The registered additions to the Society's Menagerie during the month of May were 129 in number. Of these 81 were acquired by presentation, 8 were received on deposit, 24 by purchase, 6 in exchange, and 10 were born in the Gardens.

The number of departures during the same period, by death or removals, was 117.

Amongst the additions special attention may be directed to :—

A Kashmir Deer (*Cervus hanglu*) ♀, from Kashmir, presented by H.G. The Duke of Bedford, K.G., Pres.Z.S., on May 17th.

A Reindeer (*Rangifer tarandus*) ♀, born in the Menagerie on May 22nd.

1 Galapagan Dove (*Nesopelia galapagoensis*), new to the Collection, from Hood Island, Galapagos, presented by Fleet-Surgeon E. B. Pickthorn, F.Z.S., on May 31st.

4 Grey-necked Crowned Cranes (*Bularica regulorum*), from Northern Rhodesia, presented by H.G. The Duke of Abercorn, F.Z.S., on May 8th.

3 Great Bustards (*Otis tarda*), from Spain. presented by E. J. H. Eldred on May 29th.

1 Holbrook's Terrapin (*Chrysemys mohiliensis*) and 1 Horned Lizard (*Phrynosoma brevicornis*), from N. America, both new to the Collection, presented by Dr. H. G. F. Spurrell, F.Z.S., on May 3rd.

JUNE.

The registered additions to the Society's Menagerie during the month of June were 87 in number. Of these 34 were acquired by presentation, 8 were received on deposit, 1 by purchase, 1 in exchange, and 43 were born in the Gardens.

The number of departures during the same period, by death or removals, was 102.

Amongst the additions special attention may be directed to :—

1 Red-eared Cercopitheque (*Cercopithecus erythrotis*), from the Cameroons, presented by Mrs. Philip Bayer on June 28th.

1 Black Mangabey (*Cercocebus aterrimus*), from the Belgian Congo, purchased on June 29th.

1 Lion Cub (*Felis leo*), from Western India, presented by Lieut. W. Pole Carew on June 12th.

2 Andean Geese (*Chloephaga melanoptera*), bred in the Menagerie on June 30th.

2 Colombian Crested Colins (*Eupsychortyx leucopogon*), from Colombia, presented by Master Anthony Chaplin on June 22nd.

JULY.

The registered additions to the Society's Menagerie during the month of July were 99 in number. Of these 46 were acquired by presentation, 11 were received on deposit, 9 by purchase, 5 in exchange, and 28 were born in the Gardens.

The number of departures during the same period, by death or removals, was 94.

Amongst the additions special attention may be directed to:—

2 Fennec Foxes (*Vulpes zerda*), from North Africa, received in exchange on July 24th.

1 Grizzly Bear (*Ursus horribilis*), from Wyoming, presented by Ellis Ashmead-Bartlett on July 1st.

1 Kiang (*Equus kiang*) ♂, born in the Menagerie on July 9th.

1 White-bearded Gnu (*Connochates albobubatus*), born in the Menagerie on July 24th.

2 Common Trumpeters (*Psophia crepitans*), from Guiana, and 1 Green-winged Trumpeter (*P. viridis*), from the Amazons, purchased on July 13th.

5 Common Rheas (*Rhea americana*), bred in the Menagerie on July 20th.

AUGUST.

The registered additions to the Society's Menagerie during the month of August were 75 in number. Of these 52 were acquired by presentation, 18 were received on deposit, and 5 in exchange.

The number of departures during the same period, by death or removals, was 93.

Amongst the additions special attention may be directed to:—

1 Fishing Cat (*Felis viverrina*), from India, received in exchange on August 18th.

1 Siberian Wild Dog (*Cyon alpinus*), from Central Asia, received in exchange on August 30th.

2 Arctic Foxes (*Vulpes lagopus*, blue variety), from Iceland, presented by Commander V. L. Bowring, R.N., on August 5th.

2 South American Mudfish (*Lepidosiren paradoxa*), from Para, presented by G. Brocklehurst on August 8th.

SEPTEMBER.

The registered additions to the Society's Menagerie during the month of September were 56 in number. Of these 46 were acquired by presentation, 8 were received on deposit, 1 in exchange, and 1 was born in the Gardens.

The number of departures during the same period, by death or removals, was 146.

Amongst the additions special attention may be directed to :—

1 Bornean Gibbon (*Hylobates muelleri*), from British North Borneo, deposited on Sept. 21st.

1 Southern River-Hog (*Potamochoerus chceropotamus*) ♀, from Mozambique, presented by Capt. William Dyer on Sept. 19th.

1 Pink-winged Rose-Finch (*Rhodospiza obsoleta*), from Central Asia, new to the Collection, presented by Alfred Ezra, F.Z.S., on Sept. 8th.

Yellow Varieties of Green Parrakeets.

Mr. ALFRED EZRA, F.Z.S., exhibited living examples of three rare lutino Parrakeets, and made the following remarks :—

“The three lutino Indian Parrakeets I am exhibiting were sent to me by my brother from India a few weeks ago. They represent three species—the Alexandrine (*Palaeornis nepalensis*), the Ring-neck (*P. torquatus*), and the Plum-head (*P. cyanocephalus*). In all three birds the yellow is pure and perfect, being of a delicate sulphur shade common in these lutinos. The Alexandrine has the usual red patch on the wing, and the wing-coverts adjacent to it are also edged slightly with red, making the bird very beautiful. Neither the Alexandrine nor the Ring-neck has a ring, but the Plum-head has a pink head. As they all have the full long tail they must be more than a year old. The Ring-neck and the Plum-head both have red eyes and flesh-coloured feet, but the Alexandrine's eyes are normal in colour and the feet are light: however, some races of the Alexandrine have pale-coloured feet naturally. All these birds are rare, but the Alexandrine, which is the finest-looking bird, is also the rarest of the lot, and is the first lutino of the species I have ever seen.”

Eggs from the Society's Gardens.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, gave an exhibition of Birds' eggs which had been laid in the Society's Gardens during the last few years. He explained that every endeavour was made to induce the birds under his charge to reproduce their kind in captivity, and fertile eggs were incubated where possible; but, nevertheless, in any large collection of birds there was always a number of eggs laid that did not hatch, and very often unpaired female birds laid eggs as freely as paired birds, these being of course infertile.

During recent years eggs that were not likely to hatch had been kept, with the result that a fair series was now in the possession of the Society.

Amongst the eggs of special interest shown were those of four species of Tinamous, two species of Cassowary, three species of Crane, three species of *Turnix*, the remarkable eggs of *Apteryx*, and such rarities as those of *Rhinocetus jubatus*, *Manucodia keraudreni*, and *Sarcorhamphus gryphus*, as well as a number of species of Pheasants, Waterfowl, and Passerine birds.

November 7th, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

Nestling Birds from the Society's Gardens.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a series of skins of nestling birds of over seventy species. He called attention to the striped colour-pattern which was found in such very distinct species as Rheas, Sheldrakes, and Pheasants, and remarked that this pattern was evidently of very great antiquity, and inherited from some common ancestor. Where it had proved effective for the preservation of the species by its protective resemblance to surroundings it had been retained, but in other cases it had been modified or had even disappeared altogether. In the case of most of the ducks, the stripes had been broken up into spots, but showing more or less the same pattern as in the striped type of markings. In the Gulls, Waders, and others the stripes had been further broken up into spots, and in the Swans, Geese, and Rails all markings had disappeared.

Mr. Seth-Smith called attention to the young of the Coscoroba Swan (*Coscoroba coscoroba*), and remarked that this was the only swan, if, indeed, it was a swan, which showed a distinct colour-pattern in the nestling down.

Scent-Glands in Mammals.

(Text-figures 1-12.)

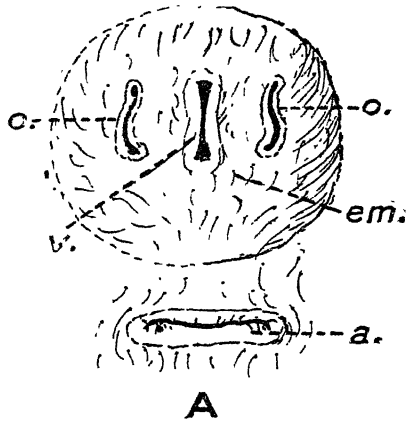
Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Curator of Mammals, exhibited a series of lantern-slides to illustrate the position and structure of some new and little-known cutaneous scent-glands in various mammals, and made the following remarks:—

The Inguinal Glands of Orycteropus.

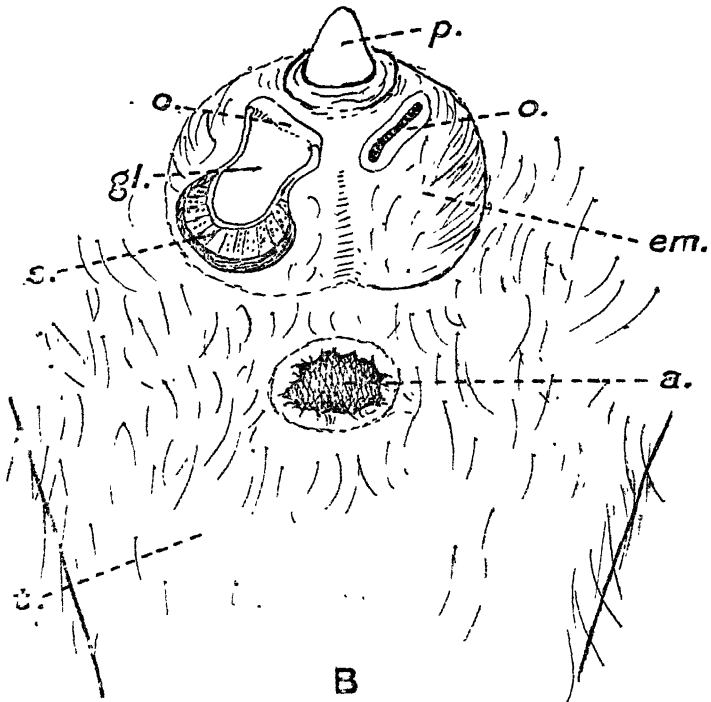
My search for special scent-glands in *Orycteropus* was instigated by the strong smell given off by the living animal, and was rewarded by the discovery, first in a female and then in a male, of a pair of large glands upon the genital eminence. In the female they lie one on each side of the vulva, and in the male just behind the prepuce and the short conical glans penis.

The orifice of each gland is an elongated slit, which, when constricted and closed, may easily be overlooked. It leads into a short wide sac filled with yellow secretion, smelling like that of the anal glands of a Polecat (*M. putorius*). The layer of glandular cells is thick and envelops the lower portion of the wall of the sac, which is provided with a strong constrictor muscle. In the male these two glands, imbedded in the integument just behind the penis and with their orifices tolerably close together, cause a swelling which superficially resembles a scrotum. In the female there is a somewhat similar swelling with the vulva in the centre and the glands, which are widely separated, on each side of it.

Since these glands, so far as can be judged from the material examined, are equally well developed in the two sexes, they



A



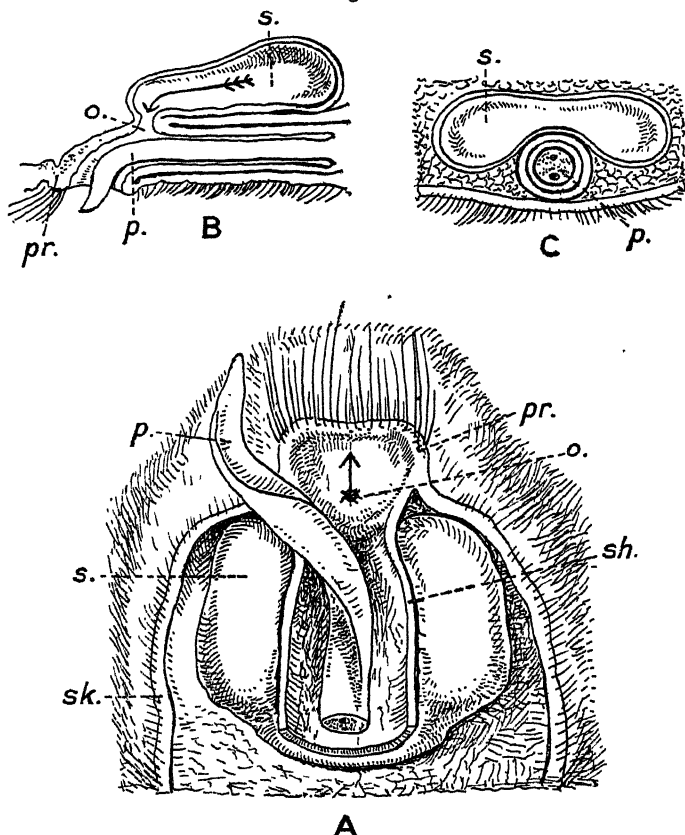
B

Inguinal glands of *Orycteropus capensis*.

- A. Glands of the female. *a.*, anus; *em.*, genital eminence; *v.*, vulva; *o.*, orifices of the glands.
- B. The same of the male with the gland of the right side (left of figure) laid open to show the reservoir or sac (*gl.*) and the secreting layer of cells (*s.*); *p.*, penis; *t.*, base of tail; *a.*, *em.*, *o.*, as in fig. A.

cannot be included in the category of secondary sexual characters, although their scent may enable individuals of *Orycteropus* to find one another; and since these animals are otherwise unprovided with means of self-defence, I suspect that the secretion of the glands is protective like those of the anal glands of *Mephitis* and *Mustela*, which it resembles in odour.

Text-figure 2.

The preputial gland of *Sus scrofa*.

- A. The gland dissected from the ventral side, the flaps of abdominal integument and of the sheath of the penis turned aside. The glans penis also turned aside to show the orifice of the gland in the prepuce.
 B. Lateral view of the same, partly diagrammatic.
 C. Transverse section through the sac of the gland showing its extension above the penis.

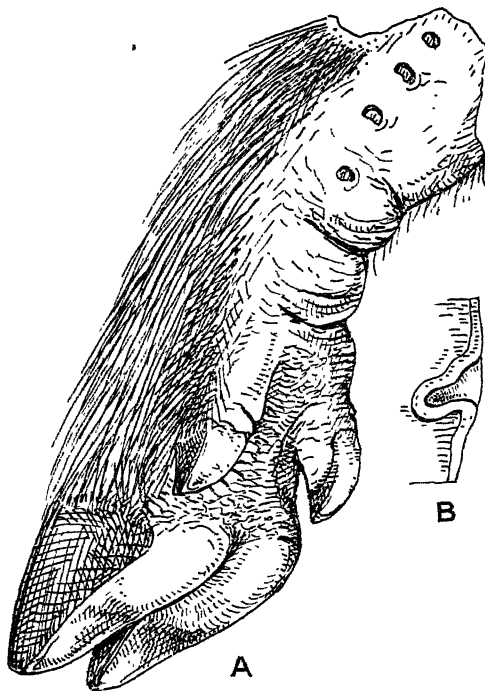
p., penis; *pr.*, prepuce; *o.*, orifice of gland; *s.*, sac of gland; *sh.*, cut edge of sheath of penis; *sk.*, cut edge of skin of abdomen.

*The Digital Glands of Potamochoerus and other glands
in the Suidæ.*

Several genera of Suidæ are provided with special cutaneous glands, all of which, with the exception of the digital glands of *Potamochoerus*, were described long ago.

In the Peccaries (*Tayassu* or *Dicotyles*) there is on the fore-part of the lumbar region a median *dorsal gland*, normally

Text-figure 3.



Carpal gland of *Sus scrofa*, ♂.

A. Inner side of right fore foot, showing the series of apertures of the gland.

B. Section through one of the pockets.

concealed beneath the bristles, which discharges secretion resembling concentrated human perspiration in scent. It was known to Cuvier, and was described and figured by Owen*. Both male and female possess it.

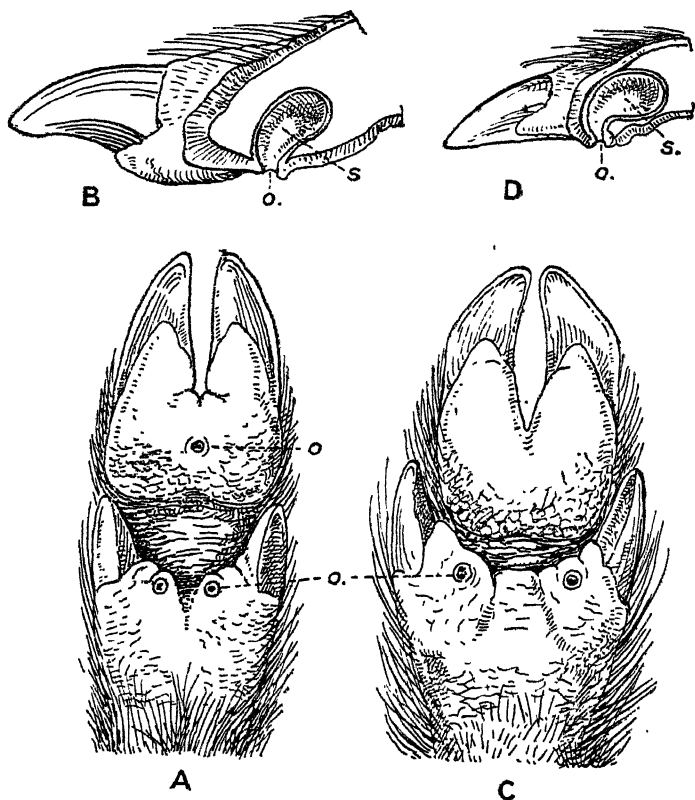
Owen also described a *facial gland* between the eye and the

* Anat. Vert. iii. Mammals, p. 636, 1868.

snout in the Wart-hog (*Phacochoerus*). This gland, which I have not seen, resembles, apparently, the analogous gland of many Ruminant Artiodactyles.

In males of the genus *Sus* there is a voluminous *preputial gland*, the sac of which lies above the distal end of the penis and

Text-figure 4.



The digital glands of *Potamochoerus charopotamus*, ♂.

- A. Lower view of hind foot, showing the apertures of the glands in the lateral digits and between the third and fourth digits of the foot.
- B. Vertical longitudinal section between the third and fourth digits of the same foot, showing the gland.
- C. Lower side of the fore foot of the same animal, showing the presence of the lateral and the absence of the median gland.
- D. Vertical longitudinal section of one of the lateral glands of the same foot.

o., orifice; s., sac of gland.

the median aperture opens in the dorsal wall of the prepuce. I have examined this gland in *Sus scrofa*; but its presence or absence in other genera and species of Suidæ has yet to be established.

In *Sus scrofa* also there is a subvertical series of small glands on the postero-inner side of the carpus and known as the *carpal glands*. The carpal and preputial glands have long been known in domestic swine, the carpal glands being present both in boars and sows.

Digital Glands of Potamochoerus.—These glands, which do not appear to have been previously recorded, I discovered on the fore and hind feet of a male example of the South African River-hog or Bush-pig (*Potamochoerus charepotamus*), which died in the Gardens, Oct. 30th, 1911.

On the fore foot there is a pair of these glands, one of them opening upon the skin of the lower side of the second digit, a little above the base of the hoof, and the other in a corresponding position on the fifth digit. Each is marked externally by a small pore with a thickened circular rim. The sac of the gland, filled with white, waxy secretion, is tolerably capacious and flask-shaped, the neck of the flask being represented by a short, narrow duct leading to the pore and bent nearly at right angles to the long axis of the gland, which projects upwards within the digit. By pressure the secretion can be squeezed from the orifice of the gland.

The hind foot has two precisely similar glands on the second and fifth digits and, in addition, a third unpaired gland nearly resembling them and opening in the centre of the sole of the foot, a short distance behind the cleft between the second and third digits. The flask-shaped sac of the gland, filled like the others with waxy secretion, lies in the foot between the bones of these digits.

I do not know whether these glands are confined to the male or not; but no trace of them was to be discovered in a young female of the West African species (*P. porcus*). Seeing that two distinct species are here concerned, it is clearly impossible to draw any sure conclusion as to the absence of these glands in the female of *P. charepotamus* and to their presence in the male of *P. porcus*. Nevertheless, the constancy in the occurrence of similar glands in nearly related species of ruminant Artiodactyles justifies, by analogy, the expectation that these digital glands will be found to be a secondary sexual character confined to the male in the genus *Potamochoerus*.

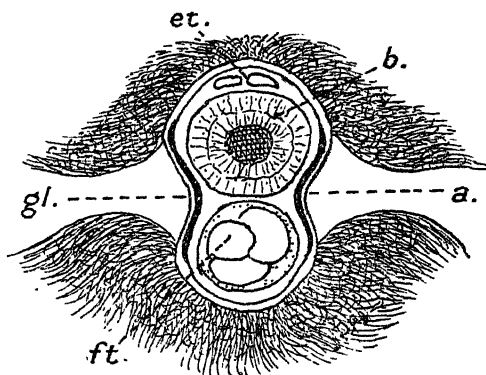
The Metatarsal Glands of Lama vicuna.

On each side of the metatarsus Llamas have an elongated naked patch of skin with which everyone who has kept these animals is probably acquainted.

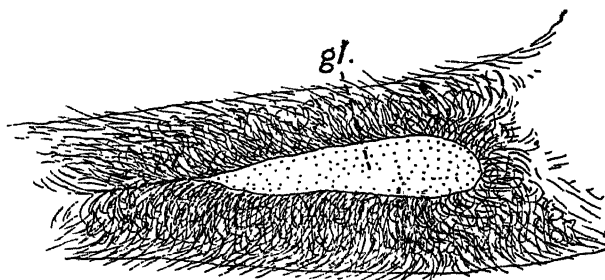
In a female example of *Lama vicuna* this area, pink in colour

and situated in the upper part of this portion of the leg, was broadest in its upper half, pointed below and bluntly rounded above. It was almost concealed by the thick coating of woolly hair surrounding it. Its surface was depressed into the hollow

Text-figure 5.



A



B

Metatarsal gland of *Lama vicuna*.

- A. Vertical transverse section through right metatarsus passing through the glandular area. *a.*, space on left side for holding the secretion between the partly separated upper and lower fringes of hair; *gl.*, naked skin with its layer of secreting cells; *b.*, metatarsal bone; *et.*, extensor, and *ft.*, flexor tendons of the foot.
- B. Upper part of same portion of limb, before being cut, seen from the inner side, with the hairs clipped short to expose the glandular area (*gl.*).

marking the point of contact between the metatarsal bone and the strong flexor tendons of the foot. A secreting layer of

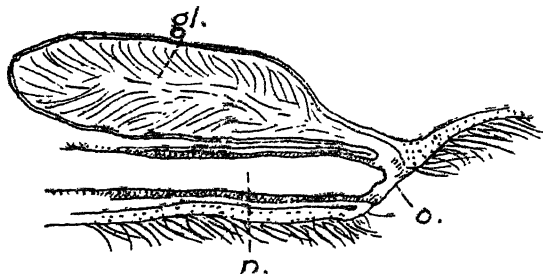
dermal cells everywhere underlies the naked area, which was covered with waxy secretion.

The Preputial Gland of Nototragus.

Up to the present time *Moschus* is the only Ruminant Artiodactyle in which a preputial gland has been discovered. I found a gland similarly situated in the Grysbok (*Nototragus melanotis*), a small African Antelope.

The sac of the gland was $1\frac{1}{2}$ inches long and 1 inch wide and narrowed anteriorly towards the orifice, which was situated in the prepuce just above the tip of the glans penis. The sac, extending backwards parallel with the penis, had its lining integument ridged and wrinkled and covered with long hairs, the tips of which were directed towards the orifice. The strong-smelling secretion, filling the sac, was dark green in colour and waxy in consistency.

Text-figure 6.



Preputial gland of *Nototragus melanotis*.

gl., sac of gland filled with hairs; p., penis retracted; o., preputial orifice common to gland and penis.

Since discovering the gland I have had no opportunity of examining male examples of *Ourebia*, *Rhaphiceros*, and other antelopes related to *Nototragus*.

The Dorsal Gland of Dendrohyrax.

In the Hyracoidea the presence of a dorsal gland, marked externally by a patch of white, yellowish, or black hairs, has long been known to systematic zoologists.

In *Dendrohyrax dorsalis* the glandular area is an elongated strip of naked skin, rather more than twice as long as broad, widest across the middle, gradually narrowed and pointed in front, more abruptly narrowed and blunter behind. The hairs surrounding it are long, black at the base and white distally. The lateral portions of the naked strip are bluish grey, minutely

and sparsely speckled with hair follicles, and show a pair of larger follicles in the anterior half, one set on each side close to the median portion of the area, which is marked off from the rest by its pinkish-yellow tint. Beneath this pink portion the dermal layer is thickened by the enlargement of its secretory cells.

When stimulated by fear or anger *Dendrohyrax* raises the hairs over the glandular area, displaying their whiteness as a conspicuous patch. The action irresistibly recalls the expansion of the rump patches by some deer and antelopes when put to flight.

Text-figure 7.

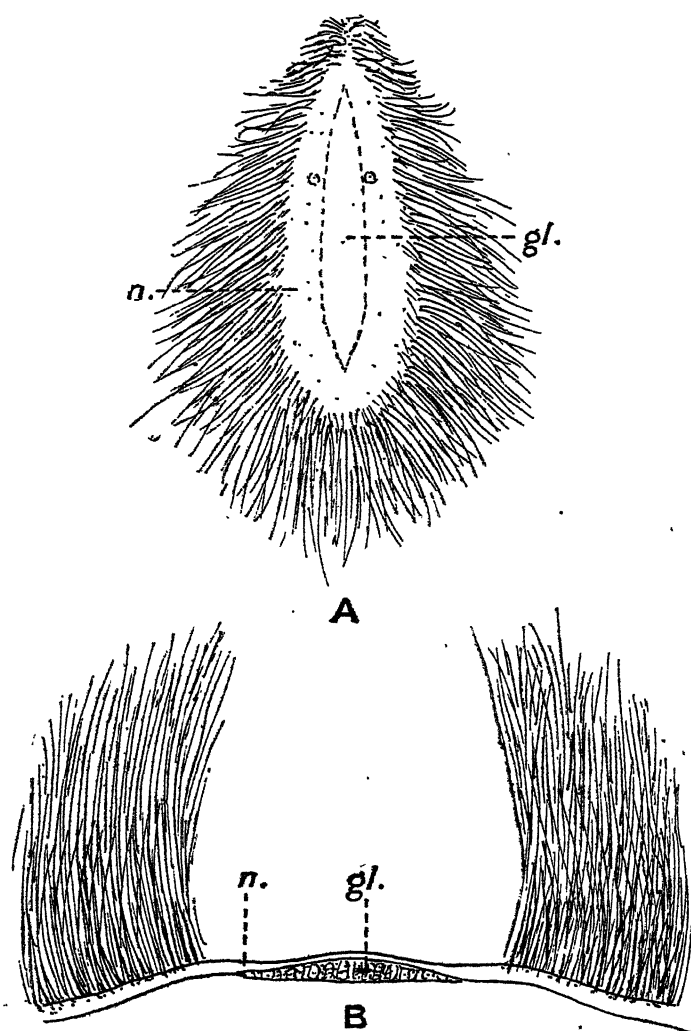


Photograph of *Dendrohyrax dorsalis* showing the white patch of hairs overlying the dorsal gland.

The Temporal Gland of Elephas and Loxodonta.

The presence of a gland on each side of the face in Elephants has long been known. Owen succinctly described it as follows:—
“In the Elephant a large gland of a flattened form and multilobate structure lies beneath the skin of the face, in the temporal region: the secretion exudes from a small orifice situated about half-way between the eye and the ear. The gland enlarges in

Text-figure 8.

The dorsal gland of *Dendrohyrax dorsalis*.

- A. Glandular area seen from above when the hairs are parted. *n.*, naked skin; *gl.*, central yellowish-pink tract overlying secreting cells.
 B. Transverse section of the above. *n.*, naked skin; *gl.*, secreting layer of cells.

Text-figure 9.

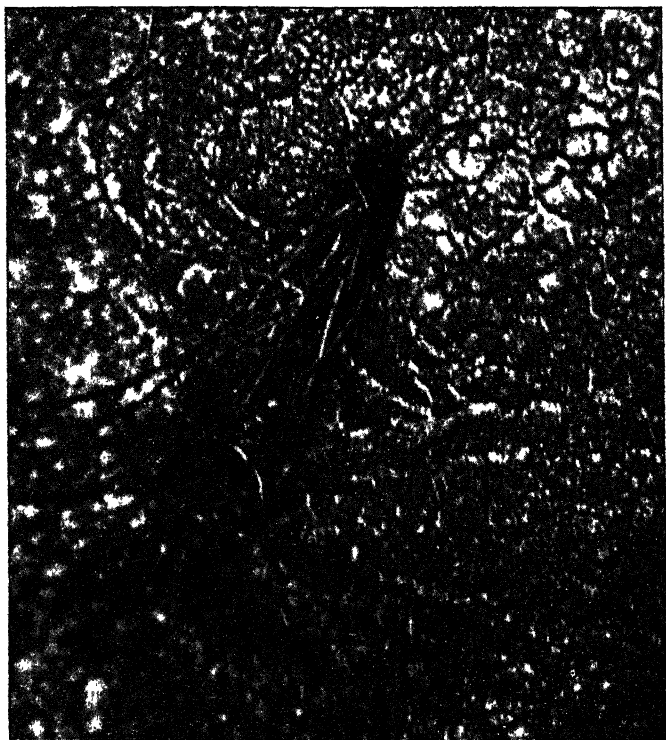


Photograph of young Malayan Elephant showing position of temporal gland between the eye and ear.

the male at the rutting season, and the secretion then has a strong musky odour" (Anat. Vert. iii. p. 634, 1868).

In an African Elephant, about twenty years old, the orifice of the gland was a vertical slit, about $\frac{1}{2}$ inch long, opening six inches behind, and a little higher than, the eye. The main sac of the gland, into which a few subsidiary sacs opened, was about two inches deep and filled with strong smelling secretion. The wall

Text-figure 10.



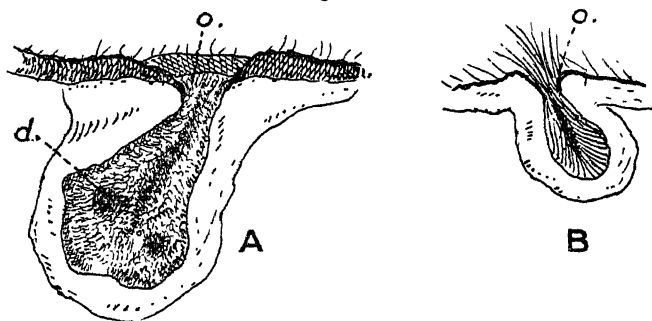
Enlarged view of the gland of young Malayan Elephant, showing tuft of hairs projecting from the orifice.

of the sac was composed of thick white skin, and its lining was hairless but covered with coarse papillæ.

In a young Malayan Elephant, about three years old, on the other hand, the sac of the gland, about $\frac{1}{2}$ an inch deep, was covered with hairs packed together with sour smelling secretion and long enough to project beyond the orifice of the gland as a

distinct black tuft very noticeable in the living animal. In two young Indian Elephants of approximately the same age, the gland was marked by no such tuft, and was invisible in the

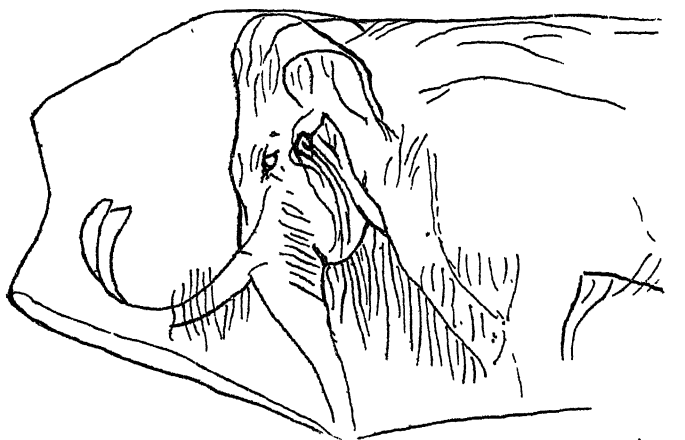
Text-figure 11.



Temporal glands of Elephants.

- A. Vertical section of sac of gland of the African Elephant (*Loxodonta*). o., orifice of gland; d., orifice of a diverticulum opening into the main sac.
 B. The same of young Malayan Elephant (*Elephas*), showing the sac of the gland filled with hairs protruding from the orifice (o.) as a facial tuft.

Text-figure 12.



Sketch of the head and fore-quarters of the La Madelaine Mammoth, showing the supposed gland between the eye and the ear. (Copied from 'Cave Hunting,' by W. Boyd Dawkins, p. 346, fig. 120.)

wrinkled chin unless carefully looked for. It is also normally invisible in adult and immature cow elephants of the Indian

species except at times when the secretion overflows and forms a dark streak down the side of the face. I have never seen a full-grown bull in rut, and am unable to speak as to the quantity of secretion discharged at that period.

In the palæolithic engraving of a Mammoth on a fragment of tusk found in the cavern of La Madelaine, by Lartet & Christy, there are between the eye and ear distinct scars, with streaks passing downwards from them over the jaws. These scars and streaks represent, I believe, the gland and the hairs on the face beneath stuck together with secretion. It will be noticed that the streaks are thicker than those shown elsewhere on the body and head, which are always interpreted as hairs; and it may be supposed that they were engraved in this way to depict hairs adherent with the sticky substance. If this interpretation be correct, the conclusion suggests itself that in the mammoth the gland may have been larger than in modern elephants, and possibly provided during life with hairs protruding through the orifice.

November 21st, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following Report on the Additions made to the Society's Menagerie during the month of October, 1916 :—

The registered additions to the Society's Menagerie during the month of October were 77 in number. Of these 51 were acquired by presentation, 11 were received on deposit, 12 by purchase, and 3 were born in the Gardens.

The number of departures during the same period, by death or removals, was 139.

Amongst the additions special attention may be directed to :—

A pair of Wild Boars (*Sus scrofa*), from the forest of Lhuyère-Sévigny, Oise, France, presented by Capt. Maurice Portal, F.Z.S., on Oct. 23rd.

1 Scater's Orange-headed Tanager (*Calospiza lunigera*) and 1 Golden Tanager (*Calospiza aurulenta*), both from Ecuador, presented by Alfred Ezra, F.Z.S., on Oct. 12th.

A Shooting Expedition in Central Asia.

Mr. ALFRED EZRA, F.Z.S., exhibited a large series of lantern-slides illustrating a shooting expedition in Central Asia, and made the following remarks :—

The pictures I am showing were taken by me on a shooting expedition in Central Asia in 1902. Starting from Calcutta, I travelled by train to Rawalpindi, and from there a drive of

200 miles brought me to Srinagar, the capital of Kashmir. Here I made all arrangements for food, followers, and transport. Soon after leaving Srinagar we successfully tackled two mountain passes. These were the Tragbal Pass, 11,700 ft., and the Burzil Pass, 13,500 ft. On the way to Gilgit I spent a few days after markhor, ibex, and bears. We did the journey of 150 miles, from Gilgit to the Pamirs, in 15 days, the progress being so slow on account of the difficult nature of the country. The mountain-tracks in places were most precipitous and dangerous. These tracks were often conducted round the edge of precipices overhanging the river by artificial ladders and ledges built out from the cliff, with stones laid upon supports of branches fitting into holes in the rocks. The most unsafe looking bit was where a log not more than 6 inches wide was thrown across, with one end of it resting on a rock jutting out 20 feet above, and the lower end on some stones. Under this there was a sheer drop of about 2000 feet into an angry river. Without the help of the fine Hunza men who were sent with us, we should have had the greatest difficulty in getting over this terrible country safely. We had our first view of the Pamir region from the top of the Killik Pass (16,700 ft.). Here we stood at the point where three great Empires meet—Russia to the north, to the east the boundaries of the Chinese Empire, and British India to the south. After shooting a few *Ovis poli* in some of the valleys in the Chinese Pamirs, I went on to the Russian Pamirs, where I shot some more. As no one ever shoots in the latter place, game was most plentiful, and one day I saw as many as 200 *Ovis poli* rams in a small valley. From here I worked my way down to the plains of Kashgaria, and it was a treat to come down from those awful altitudes and to see trees and flowers again. For over six weeks I had not been lower than 12,000 ft., and most of the time well over 14,000 ft. Leaving Kashgar at the beginning of August, I went to the Thian Shan Mountains in search of Wapiti—travelling through Maralbashi, Aksu, and Koksú—a distance of 576 miles. After shooting the Asiatic Wapiti in the Koksú Valley I went on to Kuldja, from where a drive of 850 miles in a tarantass (a four-wheeled carriage without springs) brought me to Tashkent in Russian Turkestan in 15 days. Since leaving the railway at Rawalpindi and reaching the railway at Tashkent I travelled 2583 miles in seven months, having walked and ridden 1533 miles and driven 1050 miles. Of course this does not include the enormous distances covered in search of game. From Tashkent I took the train to Samarcand and Bokhara, spending a couple of days at each of these interesting old places. A journey of 40 hours from Bokhara by train brought me to Krasnovodsk. Here I crossed the Caspian Sea to Baku in about 16 hours, and there I visited some interesting naphtha wells. From Baku I took the express to Moscow and Petrograd, making a stay of a few days at each place. Thence to Paris and home, bringing to an end a most interesting and enjoyable expedition."

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ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

October 24th, 1916.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the months of May, June, July, August, and September, 1916.

Mr. ALFRED EZRA, F.Z.S., exhibited living examples of three rare lutino specimens of Alexandrine (*Palæornis nepalensis*), Ring-neck (*P. torquatus*), and Plum-head (*P. cyanocephalus*) Parrakeets recently received from India. In all these birds the yellow is pure and perfect, being of a delicate sulphur shade. The Alexandrine is the rarest of the three, and the first lutino of this species Mr. Ezra has seen.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a number of birds' eggs which had been laid in the Society's Gardens during the last few years. The specimens shown included eggs of Tinamous, Cassowaries, Cranes, *Turnix*, *Apteryx*, and the Kagu, as well as species of Pheasants, Waterfowl, and Passerine birds.

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. S. MAULIK, B.A., F.E.S., read a paper on Cryptostome Beetles in the collection of the Cambridge University Museum. The collection is a representative one, containing species from all parts of the world. Three new genera, one new subgenus, and two new species are described.

Mr. H. G. NEWTH, A.R.C.S., F.Z.S., gave a preliminary account of his investigations into the early development of the Echinoderm *Cucumaria*. The larval life is very short as compared with that of the Auricularia. It takes place at the expense of the yolk, and is complete in about five days. Formation of the coelomic vesicles occurs by the bending and constriction of the archenteron. No separate anterior coelom appears. The hydrocoel ring closes in the left dorsal interradius, and the radial canals and five primary oral tentacles arise directly from it, alternating with one another. The internal madreporite arises as a secondary differentiation of the walls of the stone-canal.

Mr. R. E. TURNER, F.Z.S., F.E.S., communicated a paper on the Wasps of the genus *Pison*. 109 species are dealt with, of which 15 are described as new. Reasons, drawn from the numerical distribution of the species in different areas, are given for supposing the genus to be in a declining state—fifty of the total number of species being from the continent of Australia. In addition to *Pison* the small allied genera *Aulacophilus* and *Pisonopsis* are dealt with, one new species of the former being described.

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 7th, 1916, at 5.30 P.M., when the following communications will be made:—

D. SETH-SMITH, F.Z.S.

Exhibition of specimens of various nestling Birds.

R. I. POCKOCK, F.R.S., F.Z.S.

Exhibition showing some undescribed or little-known Scent-glands in Mammals.

F. E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.

On Two new Species of Cestodes belonging respectively to the Genera *Linstovia* and *Cotugnia*.

JAMES F. GEMMILL, M.A., M.D., D.Sc., F.Z.S.

Notes on the Development of the Starfishes *Asterias glacialis* O. F. M., *Cribrella oculata* (Linck) Forbes, *Solaster endeca* Retzius (Forbes), *Stichaster roseus* (O. F. M.) Sars.

The following Papers have been received :—

B. F. CUMMINGS.

Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Mammals and Birds in the Society's Gardens.—Part II.

Lt.-Col. J. M. FAWCETT.

Notes on a Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911-13.

L. A. BORRADAILE, M.A., F.Z.S.

On the Structure and Function of the Mouth-parts of the Palæmonid Prawns.

A. DE C. SOWERBY, F.Z.S.

On Heude's Collection of Pigs, Sika, Serows, and Gorals in the Sikawei Museum, Shanghai.

Sir GEORGE F. HAMPSON, Bt., F.Z.S.

On the Classification of the Tineinæ, a Subfamily of Moths of the Family Pyralidæ.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should
be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
October 31st, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 7th, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.



The Minutes of the last Scientific Meeting were confirmed.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a series of skins of nestling birds representing more than seventy species. He called attention to the striped colour-pattern in such very distinct species as Rheas, Sheldrakes, and Pheasants, and remarked that this pattern was evidently of very great antiquity and inherited from some common ancestor. He also drew attention to the young of the Coscoroba Swan, which was the only swan—if, indeed, it was a swan—that showed a distinct colour-pattern in the nestling down.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited a series of lantern-slides to illustrate the position and structure of some new and little-known cutaneous scent-glands in Mammals, and drew special attention to the presence of inguinal glands in *Orycteropus*, digital glands in *Potamochoerus*, metatarsal glands in *Lama*, and a preputial gland in *Nototragus*, which apparently had not been previously described.

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., read a paper containing the descriptions of two new species of Cestodes. The first species was obtained from a Slow Lemur and was referred to the genus *Linstowia*; the second occurred in a Black-headed Partridge and was placed in the genus *Cotugua*.

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Dr. J. F. GEMMILL, M.A., M.D., F.Z.S., gave an account of his paper on the development of some Starfishes.

Asterias glacialis.—A small solid outgrowth from the stomach-wall is found in nearly all early larvæ, and a brood occurred in which this outgrowth was larger, developed a central cavity, and fused with the backwardly growing coelomic cavity of the left side. It is interpreted as a rudimentary posterior enterocoelic outgrowth.

Cribrella oculata.—It is shown that the perihæmal pouch belonging to the madreporic interradius arises from the dorsal horn of the left posterior coelom, that the aboral skeleton arises in the form of scattered plates without definite radial and inter-radial arrangement, and that the terminals are formed by fusion of several of these plates.

Solaster endeca.—The author's previous description is supplemented in various points, including the following:—(1) All the perihæmal pouches arise from the posterior coelom; (2) there are outgrowths from the posterior coelom to form the preoral coelom in all the interradii; (3) closure of the hydrocoele-ring takes place in interradius viii./ix.; (4) the mouth-angle plates and anterior processes of the first ambulacra arise as single continuous calcifications.

Stichaster roseus.—The early development of this species resembles that of *Asterias rubens*, and, although the larvæ were not reared to their later stages, it is inferred as almost certain that the final larval form will prove to be a brachiolaria attaching itself at metamorphosis.

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 21st, 1916, at 5.30 p.m., when the following communications will be made:—

ALFRED EZRA, F.Z.S.

Lantern Exhibition illustrating a Hunting Trip in Central Asia.

Prof. B. PETRONIEVICS & Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S.

On the Pectoral and Pelvic Arches of the London specimen of *Archæopteryx*.

B. F. CUMMINGS.

Studies on the Anoplura and Mallophaga, being a Report upon a collection from the Mammals and Birds in the Society's Gardens.—Part II.

Lt.-Col. J. M. FAWCETT.

Notes on a Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911-13.

The following Papers have been received :—

L. A. BORRADAYLE, M.A., F.Z.S.

On the Structure and Function of the Mouth-parts of the Palæmonid Prawns.

A. DE C. SOWERBY, F.Z.S.

On Heude's Collection of Pigs, Sika, Serows, and Gorals in the Sikawei Museum, Shanghai.

Sir GEORGE F. HAMPSON, Bt., F.Z.S.

On the Classification of the Tineinæ, a Subfamily of Moths of the Family Pyralidæ.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
November 14th, 1916.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 21st, 1916.

Dr. S. F. HARMER, M.A., F.R.S., Vice-President,
in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions made to the Society's Menagerie during the month of October.

Mr. ALFRED EZRA, F.Z.S., gave an account of a shooting expedition in Central Asia, and illustrated his remarks with a very fine series of lantern-slides.

Dr. B. PETRONIEVICS and Dr. A. SMITH WOODWARD, F.R.S., V.P.Z.S., read a paper on some new parts of the pectoral and pelvic arches lately discovered in the London specimen of *Archaeopteryx*. The coracoid bone most closely resembles that of the ratite birds and the Cretaceous *Hesperornis*. The pubic bones are twice as long as the ischia and meet distally in an extended symphysis, gradually tapering to a point, which seems to have been tipped by a mass of imperfectly ossified cartilage.

Mr. B. F. CUMMINGS contributed a paper entitled "Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Mammals and Birds in the Society's Gardens—Part II." This paper continues the account of the Mallophaga, and contains descriptions of five new genera and two new species. Some observations are made upon the spermatophores in a genus parasitizing the Ibises, and emphasis is laid on the frequently

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remarkable differences found in the structure of the internal organs, especially those of the male reproductive system.

Lt.-Col. J. M. FAWCETT communicated a paper on a collection of Heterocera made by Mr. W. Feather in British East Africa.—Of the 124 forms dealt with, 45 are described as new, together with 7 new genera.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 6th, 1917, at 5.30 P.M.

The agenda will be announced early in January.

The following Papers have been received :—

L. A. BORRADAILE, M.A., F.Z.S.

On the Structure and Function of the Mouth-parts of the Palæmonid Prawns.

A. DE C. SOWERBY, F.Z.S.

On Heude's Collection of Pigs, Sika, Serows, and Goralis in the Sikawei Museum, Shanghai.

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Communications intended for the Scientific Meetings should be addressed to

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Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
November 28th, 1916.

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